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DETERMINATIONS OF ATMOSPHERIC TURBIDITY AND WATER VAPOR CONTENT

By Herbert H. Kimball

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Introduction.—Early in 1931, at a meeting of the commission on solar radiation of the section of meteorology, International Geodetic and Geophysical Union, in Potsdam and Berlin, Germany, after a thorough discussion it was voted to recommend to the national branches of the Union that they cooperate in a world-wide study of the dustiness or turbidity of the atmosphere, and also of the water vapor content.

The commission recommended that glass color filters be utilized to separate out from the complete solar spectrum the bands that were free from water vapor absorption; and the Magnetic-Meteorological Observatory at Potsdam was asked to procure glasses of suitable quality and of uniform thickness and spectral transmission, and to test them for quality and uniformity throughout.

With characteristic thoroughness, the observatory secured a considerable quantity of OG1 (yellow) and RG2 (red) Schott filter glass. From large sheets, disks of suitable size were cut, ground to uniform thickness, and their spectral transmissions carefully determined. The results of these tests were published by Feussner, Met. Zeit. 1932, Heft 6, S.242–244; they have been reproduced in this Review, March 1933, volume 61, pages 80–82.

Early in 1932 a set of these filter glasses was received at the United States Weather Bureau; and later in the same year a second set was received at the Blue Hill Meteorological Observatory of Harvard University.

Check readings made by the United States Bureau of Standards on both sets of these screens gave results in close accord with the Potsdam tests. During the following winter these tests were repeated at the Bureau of Standards, and also at the Smithsonian Institution; these tests made in cold weather gave slightly higher transmissions than did the earlier tests made in midsummer heat. Feussner states that the temperature of the screens when undergoing test in his laboratory was between 20° and 25° C.; it is here assumed that the mean of the temperature during his tests was 22.22° C., which corresponds with 72° on the Fahrenheit scale.

The effect of temperature on the transmission of glass filters receives more complete treatment later in the present paper.

In the United States, the United States Weather Bureau and the Blue Hill Observatory of Harvard University have made solar radiation records with these filters since 1933. All measurements have been utilized in obtaining values of the turbidity coefficient, β, and of the water vapor content, w, of the atmosphere. While the first measurements did not yield as accurate results as could have been wished, they indicated defects that have been remedied and which could not have been discovered except through experience.

In middle and northern Europe, a very complete system of observing stations was early established. The locations of some of the mountain stations are excellent, and from some use the writer has made of them for other purposes they are judged to hold much promise for the calculation of atmospheric turbidities and water-vapor contents over a wide range of territory. It is hoped this material does not long remain unavailable; so far as can be learned, neither the Weather Bureau library nor the library of the Blue Hill Meteorological Observatory has yet received any values of β or w derived from the measurements made at the European stations.

A considerable literature on the subject of this paper already exists, references to a part of which will be found at the end of the paper. A complete bibliography does not seem to be required here, because the specific purpose for which this paper has been written is to place on record the technique that has been developed at Blue Hill, largely under grants from the Milton fund of Harvard University, for determining the atmospheric tubidity and water vapor content.

The technique which was first developed and published by Ångström (1), is here considerably modified, especially with reference to the effect of the temperature of Schott glass filters upon their transmission of solar radiation.

Ångström's atmospheric turbidity coefficient, β, is preferred to Linke's (2) coefficient, T, for the reason that Linke includes in this one term, T, all depletion of the solar rays as they pass through the atmosphere to the place of observation; while Ångström separates depletion due to scattering from that due to absorption, and thus makes possible a close approximation to the water vapor content of the atmosphere above the place of observation.

Pyrheliometric apparatus and its exposure at Blue Hill.—On the monument which stands beside the path leading to the observatory, and which was erected to the memory of the founder, Professor Rotch, it is stated that he was a "Pioneer in the study of the upper air" (fig. 1). At that time this study was made by means of delicate instruments that were taken to considerable heights by kites or balloons. Now we learn much about the upper atmosphere from its effects on the solar rays as they pass through it on their way to the surface of the earth. Therefore, the present director, C. F. Brooks, was only expanding the program of the founder when he added measurements of the intensity of incoming solar radiation to the daily routine of the observatory.

In figure 1, just to the left of the monument, is a glimpse of the top of the observatory tower. Just past the crest of the hill, the observatory is seen as it appears in figure 2; in the side of the tower shown, which is the north side, are three windows, one above another, and the central one has in it an instrument shelter of a style in common use at the time the observatory was built. A modern shelter is now located on the ground, farther to the northeast.

This picture was taken during the celebration of the fiftieth anniversary of the founding of the observatory. In the pathway, from left to right, are President Conant; Charles Francis Adams, chairman, executive committee of the board of overseers, Harvard University; W. S. Gifford, and M. Simons, members of the board of visitors, Blue Hill Meteorological Observatory.

Figure 3 is a closer view of the tower. Note the openings in the parapet. There are eight of these openings: The one nearly in front is the easternmost. The second one to the left is in the south side of the parapet and in front of this opening a concrete pier has been built up to the height of the bottom of the opening. At its base the thickness of the pier from north to south is considerably greater than at the top, and its width from east to west exceeds throughout its thickness from north to south. One of the leveling screws, or pins, of the equatorial mounting for the Eppley thermopile rests on the bottom of the south opening in the parapet, while two others rest on the pier. This makes a support for the equatorial and the thermopile it carries, which is as stable as the tower itself.

By means of the three leveling screws, the support is easily adjusted to the vertical, and a pair of screws enable the instrument to be accurately pointed toward an object near the horizon several miles away that is shown by geodetic-survey maps to be only a very small known angle from due south of the observatory tower. With the thermopile tube properly mounted on this support, and adjusted each day for solar declination and each morning for solar hour-angle, it is a simple matter to correct the setting before obtaining each series of solar-intensity records on the Leeds and Northrup micromax recorder.

Figure 4 shows the thermopile tube, mounted on the equatorial, in operation. Over the upper end of the tube is a quartz plate, one-half millimeter thick, that protects the thermopile from disturbance by the wind. Above the end of the tube is a Schott glass color filter; two of these filters are mounted on opposite sides of a spindle that is turned by hand to bring the desired filter over the end of the tube or to remove both of them.

Beyond the parapet and apparatus in figure 4, is a glimpse of the valley to the southwest of Great Blue Hill. The terrain beyond the east slope of the range, as shown in figure 4, consists principally of forested areas, scattered lakes, and cultivated fields. The western slope is more gentle than the eastern, and in the earlier days of the observatory a carriage road was built up this slope; it may still be used by horse-drawn vehicles, but is closed to automobiles. The Blue Hill Range ends very abruptly just beyond the observatory, so that from the south and west the observatory has the appearance of occupying an isolated peak. To the north, the center of Boston is about 11 miles distant; and in the morning the horizon in that direction is usually obscured by smoke, which often lifts in the afternoon. Through the valley to the west is a line of suburban towns served by the New York, New Haven & Hartford Railroad; but the smoke from the trains is so well controlled that this valley is usually quite free from smoke. The density of the smoke or haze prevailing at the time screened readings are obtained is indicated on a scale of 10 units which give the distinctness and distance to which large objects can be seen. Mount Monadnock, at a distance of about 67 miles, in New Hampshire, with an elevation of 3,166 feet, and Mount Wachusett, elevation of summit 2,096 feet and distance from the observatory 44 miles, are visible only when the visibility is rated 9 or 10.

There are a number of hills and other objects that help fix the degree of visibility, or measure the transparency of the atmosphere. The results are tabulated and published monthly as an auxiliary to table 3, Solar Radiation Observations, in this REVIEW.

Since Blue Hill is in a metropolitan forest reserve area, and since there are also other forest reserves in the vicinity, the present favorable atmospheric conditions for solar radiation work may be expected to continue and possibly improve.

The measurement of solar radiation intensity.—In figure 5 is reproduced, on about half its original scale, the continuous record obtained at the Blue Hill Meteorological Observatory on December 28, 1935. The original records are made by an Eppley thermopile supported on an equatorial mounting as shown in figure 4, and carefully adjusted as explained above. The accuracy with which the thermopile tube is pointed on the sun is tested, and the setting corrected if necessary, before each set of screened readings. The thermopile actuates a Leeds and Northrup recording micromax potentiometer which is hung on the heavy concrete wall of a room on the first floor of the tower, and with which it is in electrical contact through well insulated copper leads. Before it was issued by the Eppley Laboratory, the 10-junction thermopile was carefully calibrated on a Leeds and Northrup micromax recording potentiometer, similar in every respect to the one in use at the Blue Hill observatory. The calibration showed that one division on the record sheet indicated a radiation intensity of 0.05 gram cal./min./cm^2 of surface.

On each clear day the Smithsonian silver disk pyrheliometer, which is preserved as a standard of reference at the observatory, is read; its reading is corrected for the temperature of the bulb and the temperature of the stem, a calibration correction applied for that part of the stem at which the reading was made, and the corrected reading multiplied by the constant for this particular instrument, which is 0.3827. This shows that the thermometer in this pyrheliometer is a sensitive one.

In table 1, which follows, are given the ratios, Smithsonian to Eppley, the latter values recorded as they were read from the record sheet for the time at which the Smithsonian pyrheliometer was read. It will be noted that these ratios vary from day to day, and to a less extent from hour to hour, and that in general the clearer the sky the higher is the ratio. The variation from low sun to high sun may be explained by the fact that the sky is relatively brighter about the sun when the sun is low than when it is high in the heavens. It is known that pyrheliometers, and other similar instruments for measuring solar radiation intensity, include in the measurement the radiation from a small ring of the sky surrounding the sun. To eliminate this as far as possible, the Smithsonian Institution uses a vestibule in front of the blackened absorbing surface, of such length as to require special means for supporting and handling it (3).

Probably the variations in the ratios of table 1 are due to the slightly larger percentage area of skylight to which the Eppley thermopile is exposed as compared to

Figure 1.

Figure 2.

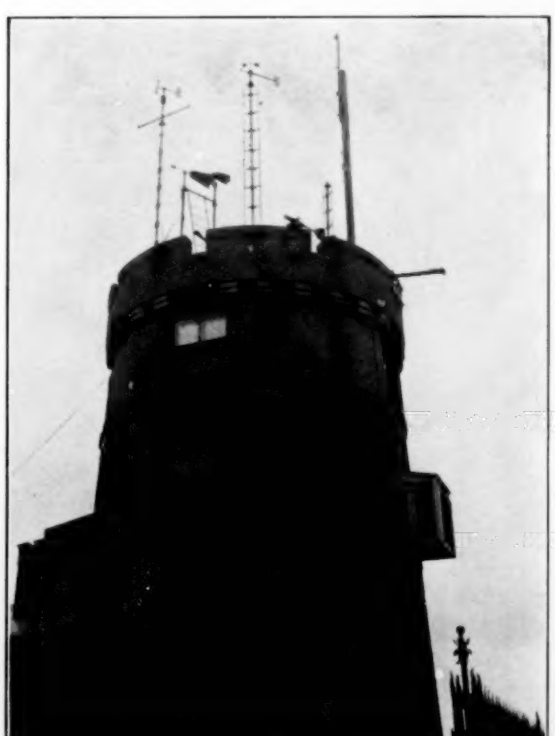

Figure 3.

Figure 4.

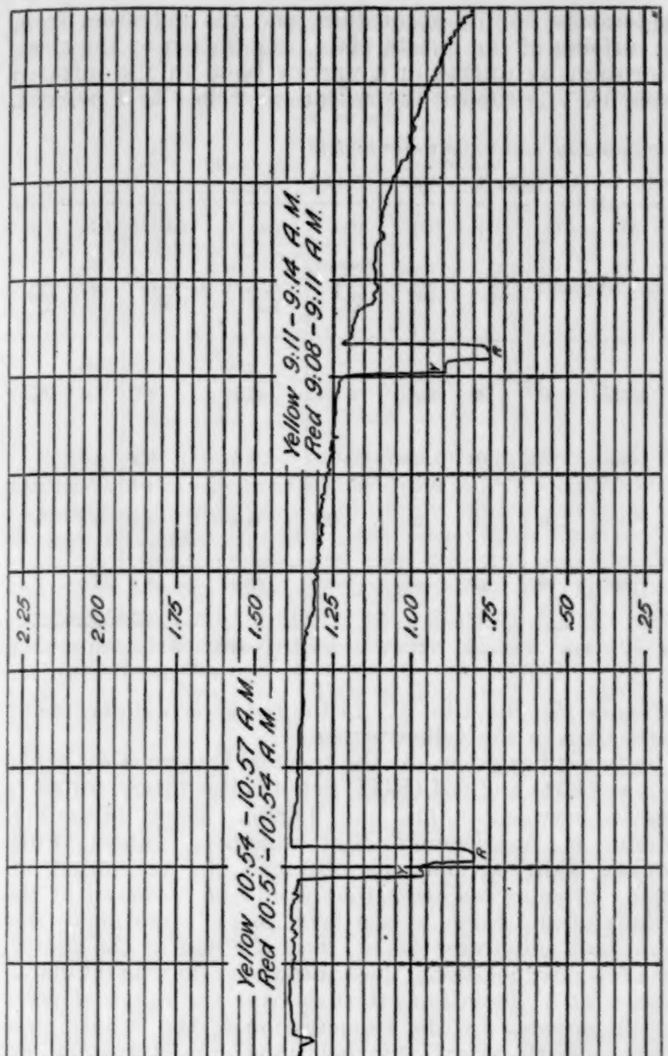

Figure 5

that from which the Smithsonian pyrheliometer receives radiation, since the clearer the sky, the larger the ratio Smithsonian (gr. cal.)/Eppley (scale). The discrepancy would be eliminated if the two instruments had vestibules that offered the same angular opening from their respective blackened surfaces to the sky; in the meantime, the ratios from table 1 for each day must be employed in reducing scale readings from figure 5 to radiation intensities expressed in heat units, else the turbidity values computed by the method to be explained would show discrepancies.

TABLE 1.—*Ratio of Smithsonian pyrheliometer readings to scale readings of the Eppley thermopile recording on Leeds and Northup micromax automatic register*

1935	Time	Smithsonian pyrheliometer gr. cal./min./square cm.	Eppley thermopile: Scale readings	Ratio: Smithsonian/Leeds and Northup scale reading
Dec. 3	9:08 a. m.	1.028	2.23	0.461
Dec. 4	1:32 p. m.	1.244	2.55	.488
Dec. 6	9:42 a. m.	1.290	2.79	.462
Dec. 12	8:50 a. m.	.959	1.92	.499
Dec. 17	3:48 p. m.	.431	----------	----------
Dec. 18	8:56 a. m.	.956	2.05	.466
Dec. 21	8:46 a. m.	.951	1.98	.480
Do	11:30 a. m.	1.274	2.59	.492
Dec. 22	8:54 a. m.	1.172	2.38	.492
Do	11:30 a. m.	1.380	2.84	.486
Do	12 noon	1.386	2.85	.486
Dec. 23	10:10 a. m.	1.151	2.37	.486
Dec. 25	11:16 a. m.	1.357	2.74	.495
Dec. 27	11:28 a. m.	1.313	2.64	.497
Dec. 28	12:10 p. m.	1.395	2.77	.503
Dec. 31	12:14 p. m.	1.418	2.82	.503

Note that the ratios in the last column of this table are, on an average, in good agreement with Eppley's calibration value.

To illustrate the method of computing β and w, there are tabulated in full in table 2 the radiation data for December 28 obtained from figure 5 by the use of the ratios for the same date in table 1. Note that the time entered on figure 5 for each series of measurements is standard seventy-fifth meridian time, on which all Blue Hill observatory recording instruments are run. In table 2, the time is reduced to true solar, or apparent time, but is entered as hours and minutes before or after apparent noon, for convenience in computing the solar altitude and the air mass or relative length of path of the solar rays in the atmosphere; unit air mass is the length of path when the sun is in the zenith and the barometric pressure is 760 millimeters. By interpolation in Ball's Altitude and Azimuth tables (**4**), the altitude of the sun has been tabulated for the latitude of Blue Hill observatory for each degree of solar declination from +24° to −24°, and at 4-minute intervals from shortly after sunrise to within a few minutes of sunset. From the sun's altitude, the corresponding air mass may be obtained from table 100, page 226, Smithsonian Meteorological Tables, Fifth Revised Edition, 1931, or other sources. These air mass values are computed for an air pressure of 760 millimeters; and at Blue Hill, because of the elevation, the values derived in this way must be reduced by multiplying by 0.98.

In table 2, following the air mass are the measured solar radiation intensities designated in the column headings I_m, I_y, and I_r; these are respectively intensities for the total solar spectrum, for that part of the spectrum transmitted by the yellow filter and by the red filter. Directly under these values are the values of I_m, I_y, and I_r, reduced to what their values would have been if obtained at the mean distance of the earth from the sun. At this season of the year the earth is very near its point of minimum distance from the sun. Finally, under I_m a third value represents the intensity of the radiation in the entire solar spectrum, after reduction to mean solar distance

and division by Abbot's mean value of the solar constant, 1.94, expressed as a percentage.

The values I_y and I_r have next to be corrected for the absorption by the glass filters, including the effect of temperature on the absorption, and the reflection from the surfaces of the quartz plate, in addition to the small absorption by quartz in a narrow band in the infrared (table 3). As shown, the reflection is close to 9 percent.

TABLE 2.—*Thermopile reductions, atmospheric turbidity, and water vapor content*

[Blue Hill Meteorological Observatory of Harvard University, lat. 42.2°; long., 71.1°; altitude, 670 feet]

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Date and hour angle	Solar altitude	Air-mass	I_m	I_y	I_r	I_y / $0.851+c$	I_r / $0.840+c$	(4)−(8)	(7)−(8)	β (9)	β (10)	Mean of (11) and (12)	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
1935, Dec. 28	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*										*mm.*	
2:35 a. m.	20 29	2.24	1.227 1.187 61.2	0.895 .865	0.757 .732	1.009	0.864	0.323	0.145	0.055	0.074	0.064	63.9	2.7	1.4	P_A
0:51 a. m.	23 24	2.51	1.383 1.337 68.9	.973 .941	.805 .778	1.098	.919	.418	.179	.028	.028	.028	75.5	6.6	4.2	
0:38 p. m.	23 53	2.46	1.378 1.333 68.7	.956 .925	.805 .778	1.079	.919	.424	.160	.032	.032	.032	74.4	5.7	3.5	
2:08 p. m.	18 06	3.16	1.252 1.211 62.4	.915 .885	.739 .715	1.033	.844	.367	.189	.026	.026	.026	70.8	8.4	4.6	P_A

Dec. 28, 1935: Time correction for longitude, −15 minutes, 32 seconds; for equation of time, +1 minute, 25 seconds. Total correction, 75th meridian to apparent time, −14 minutes 7 seconds.

TABLE 3.—*Reflection and transmission of radiation through a quartz tube 29.915 millimeters long*

Wave length	Reflection	Wave length	Trans-mission	Transmission through thin plates computed by H. H. Kimball, from foregoing. Transmission for plate: 1 millimeter thick	0.5 milli-meter thick
μ	*Percent*	μ			
0.325	0.9062				
.340	.9069				
.358	.9077				
.361	.9078				
.396	.9091				
.405	.9094				
.410	.9095				
.434	.9101				
.486	.9113				
.508	.9115				
.5349	.9119				
.5893	.9125	0.5893	0.9958		
.6158	.9127				
.643	.9129				
.6563	.9130				
.6678	.9130				
.6768	.9131				
.686	.9133				
.7065	.9134				
.7435	.9136				
.760	.9137				
.7682	.9138				
.8007	.9139				
.8325	.9141				
.8671	.9142	.8820	.9955		
.9325	.9145				
1.0715	.9145				
1.2215	.9154				
1.376	.9159				
1.670	.9169	1.6132	1.0000	1.000000	1.000000
1.870	.9176	1.7835	.9999	.999999	.999999
1.999	.9181	1.9518	.9976	.999992	.999962
2.170	.9188	2.1128	.9948	.999838	.999914
2.384	.9198	2.2654	.9880	.999598	.999809
2.574	.9207	2.4098	.9795	.999310	.999655
2.746	.9218	2.5458	.9555	.998488	.999242
2.904	.9226	2.6120	.9399	.997936	.998852
3.058	.9235	2.6757	.9272	.997484	.998741
		2.7392	.8446	.994386	.997189
		2.8010	.5789	.981946	.990931
		2.9213	.0814	.919782	.959055
		3.0373	.1549	.939727	.969395

See Coblentz, W. W. Absorption, Reflection, and Dispersion Constants of Quartz. Bull., U. S. Bureau of Standards, vol. 11, no. 3, pp. 471–481; May 10, 1915.

The absorption, while apparently inconsequential, could not be disregarded, for the reason that it all occurs in a band between 2.00μ and 3.00μ, where, according to Feussner (5), the intensity in the red screen is decreasing faster than in the yellow screen.

Feussner has given (5) the spectral transmission of the yellow (OG1) and red (RG2) Schott glass filters, for wave lengths between 0.511μ and 2.860μ. From table 111, column 6, Smithsonian Meteorological Tables, Fifth Revised Edition, may be obtained the computed intensity of solar radiation that would be observed at the surface of the earth at sea level in an atmosphere free from dust and water vapor, with the sun in the zenith. By a few interpolations, these intensities may be tabulated from w at 5′ deviation intervals over the range of wave lengths covered by the transmission of the Schott glass filters. With slight interpolations, the transmissions may be tabulated for the same wave lengths as the intensities. There remains only a small amount (less than 3 percent of the total) for which the distribution of intensity must be estimated, but for which the transmissions in the infra-red are available as an aid.

Evidently, the sum of the products of intensities by transmissions, divided by the sums of the intensities, gives for each screen the average transmission for that part of the spectrum it transmits. In this way it has been determined that the transmission of the yellow filter (OG1) is 0.851, and that of the red filter (RG2) is 0.840; these values have been determined when the temperatures of the screens were between 20° and 25° C.

As to the change in transmission of these screens with temperature, Gibson (6) found that for a decrease in temperature from +20° C. to −80° C., a decrease of 100° C., the increase in transmission for the yellow screen is 1.96 percent, or 0.2 percent per 10° decrease. With a temperature increase from +20° C. to +100°, an increase of 80° C., the decrease in transmission for the yellow screen is 2.85 percent, or 0.356 percent per 10° increase. For red screen (RG2), a decrease in temperature from +20° C. to −80° C. or 100° C., causes a percentage increase in transmission of 2.44, or 0.244 percent per 10° C.; and for an increase in temperature from +20° C. to +100° C., or 80° C., the decrease in transmission is 2.185 percent, or 0.273 percent for 10°.

We thus obtain the following tables of transmissions to be used in determining the radiation intensity in the

spectral bands that are transmitted by Schott glass filters OG1 (yellow) and RG2 (red):

TABLE 4.—*Transmission coefficients for different temperatures of screens*

Temperature		Transmission	
° F.	° C.	OG1	RG2
−36	−38	0.863	0.855
−18	−28	.861	.852
±0	−18	.859	.850
+18	−8	.857	.847
+36	+2.2	.855	.845
+54	+12.2	.853	.842
+72	+22.2	.851	.840
+90	+32.2	.847	.837
+108	+42.2	.844	.835

Baker (8) has made extensive measurements of the temperature of the Schott glass color filters when exposed to sunlight, as they are for 3 minutes while measuring the intensities I_y and I_r. His measurements, summarized in table 1 of the next paper in this REVIEW, indicate that the color screens have at the beginning of exposure a temperature 1.2° C. above air temperature, and that the average excess during the 3 minutes exposure is 1.4° C.; thus, there is an average total excess of 2.6° C. above air temperature. This is indicated in table 2, in the headings of columns (7) and (8), by writing in the denominator of each fraction, after the number that denotes the value of the transmission at temperature 22.2° C., the letter *c*., to indicate that a correction is to be applied to make the denominator agree with the value given in table 4 at the temperature of the screens.

Returning now to table 2, we find that the divisors throughout December 28 were 0.857 for the yellow screen and 0.847 for the red, appropriate to a midday temperature of about +17° F., or −9.3° C. for the air, and about −6.7° C. for the glass screens.

From this point on, the work in table 2 is simple: Each set of values of I_y and I_r is divided by its transmission coefficient, determined in the same manner as in the example just given. The value of I_r thus obtained is then subtracted successively from I_m and I_y; and from the results, by interpolation in figures 3 and 4, this REVIEW, March 1933, page 64, we obtain the value of β, the coefficient of atmospheric turbidity for the time at which the solar radiation measurements were made. Two determinations of β are obtained, one from the value of $I_m - I_r$ and the other from the value of $I_y - I_r$, representing intensities in different parts of the solar spectrum. (See above reference, figs. 3 and 4, for spectral limits in each determination.) It will be noted that the first pair of values were not in so close accord as those obtained later in the day; figure 1 shows that the intensity trace at the earlier time was not so steady as it was later, indicating possible momentary disturbances from local smoke, or, more probably, from thin clouds. During the remainder of the day, sky conditions were remarkably steady.

Using the mean values of β for each set of measurements, we obtain from figure 2, this REVIEW, March 1933, above quoted, the values for I_m in an atmosphere having the turbidity computed for December 28, expressed as a percentage of the solar constant, 1.94. Subtracting from this the value of I_m in table 2, column (4), expressed in the same units, we obtain the percentage loss that may be attributed to absorption by gases in the atmosphere. Deducting 0.3 from the total loss by absorption given in column (15), and dividing the remainder by $\sqrt{m}$, we obtain what appears to be a close approximation to the depth of water that would be formed if all the water vapor above the place of observation were precipitated.

The small amount of water vapor indicated by the morning observation is probably due to an overestimate of the loss by scattering; or in other words a too high value of β led to a too low value for w.

Under "Air mass type", in the last column of table 2, is given the probable source of origin of the air as indicated on air mass analysis maps.

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MEASUREMENT OF SCHOTT GLASS FILTER TEMPERATURES

By RICHARD F. BAKER
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In the solar radiation program at Blue Hill Meteorological Observatory, atmospheric turbidity and water vapor content are measured by a method developed by H. H. Kimball. In this method the energy in selected regions of the spectrum, received at normal incidence, is measured by means of a thermopile. Isolation of the desired spectral regions is effected by two Schott glass filters, mounted in such a way that they can be swung in and out of the incident beam in succession.

It is a well-recognized fact that the transmission of radiation through any filter that exhibits either selective or nonselective absorption is a function of temperature. The purpose of the present investigation was to measure the temperatures which the filters assumed, in order that a temperature correction to the transmission might be applied.

The filters are circular in shape, 3 centimeters in diameter, one-half millimeter thick, and are mounted as shown in figure 4 of the preceding paper by H. H. Kimball. It is obvious that a determination of the internal temperature of the filters is impracticable. A good approximation to the internal temperature is the surface temperature, which could quite easily be measured. Accordingly the surface temperature of the filters was measured under the actual conditions of use. An instrument based on the thermoelectric effect seemed most feasible for the measurement. Thermocouples were constructed and were found quite satisfactory for the purpose.

In use the filter is swung into a position such that its surface is normal to the incident beam. This position is maintained usually for 3 minutes. Two questions

present themselves: What is the temperature of the filter before exposure to direct solar radiation? What is the rise in temperature during the 3-minute exposure period?

The thermocouples were constructed of no. 34 copper wire and no. 30 constantin wire, and the junctions were soldered; the wires may be seen, in figure 4, hanging from the upper end of the thermopile tube. Current rather than emf was measured, as the conditions under which measurements were made necessitated the use of simple portable equipment. The current flowing in the thermocouple circuit is not a linear function of temperature, but this fact is of no consequence, because the thermocouple had to be carefully calibrated anyway.

It is essential that the hot junction be in intimate contact with the glass. Various modes of fastening were tried. The most satisfactory method was to bind the junction to the glass with a strip of transparent Scotch cellophane. A possible source of error lies in absorption of radiant energy by the hot junction itself—with consequent rise in temperature. This effect proved to be negligible however, because of the high thermal conductivity, low specific heat, and small cross section of the hot junction. The cellophane had the effect of shielding the glass surface and the hot junction from the moving air. Since the air would have a cooling effect and tend to reduce the rise due to absorption of radiant energy, this shielding effect was not altogether undesirable, since the greatest possible temperature change was wanted as well as the mean. The position of the hot junction proved not to be of critical importance; both front and back surfaces were used, with no difference greater than 0.5° C. found between the two.

The change in transmission with temperature as determined for these filters at the National Bureau of Standards is such a slowly changing function of temperature that the filter temperatures do not need to be known, for purposes of correction, closer than 1.0° C. The thermocouples give temperature readings which are good to 0.1° C. The lower limit of accuracy here is of course imposed by lack of galvanometer sensitivity. The thermocouple was calibrated in the usual way, using water baths of known temperature and making suitable correction for the temperature coefficient of resistance of the wire.

RESULTS

The data are collected in table 1. Comparison of columns I and IV shows that the surface temperature of the shaded screen is on the average about 1° C. higher than the free air temperature. There seemed to be no detectable characteristic difference between the temperatures of the red filter and those of the yellow filter, under comparable conditions, so no distinction has been made between them in table 1.

Most of the data were obtained in August. Observations in midwinter (January) gave comparable results, both qualitatively and quantitatively, as might be expected.

From column VI, the average rise in surface temperature of the filter in 3 minutes is 2.8° C. For correction purposes the average rise in 3 minutes is the more significant quantity, and may be taken as 1.4° C.

Under all normal conditions, the shaded filter temperature may be taken as 1° C. higher than the current air temperature.

It is obvious that the rise in temperature is a function of two independent variables, radiation intensity and wind velocity, and would be represented graphically by a surface in three dimensions. One interesting property of this surface may be noted—namely that it shrinks to a point at the origin. No attempt has been made to sketch this surface from experimental data, as the range of intensities is not sufficient to fix the shape of the surface with any accuracy.

TABLE 1

I	II		III	"Hot" junction		VI	VII
Air temperature ° C.	Galvanometer deflection in equivalent degrees: Shade	Sun	"Cold" junction	IV Shaded	V 3 minutes in sun	Rise in 3 minutes	Excess of screen temperature over air temperature
August	° C.	° C.	° C.	° C.	° C.	° C.	° C.
21.1	−1.5	+1.4	23.2	21.7	24.6	2.9	0.6
21.7	−1.5	+1.5	23.5	22.0	25.0	3.0	.3
21.9	−.5	+2.5	23.5	23.0	26.0	3.0	1.1
22.2	−1.5	+1.6	24.0	22.5	25.6	3.1	.3
22.2	−2.4	+.3	26.5	24.1	26.8	2.7	1.9
22.2	−3.5	−1.0	26.0	22.5	25.0	2.5	.3
23.9	−5.3	−2.2	31.0	25.7	28.8	3.1	1.8
23.9	−4.8	−2.2	31.0	26.2	28.8	2.6	2.3
23.9	−6.3	−.8	31.5	25.2	30.7	5.5	1.3
23.9	−3.5	−1.8	31.5	28.0	29.7	[1] 1.7	[1] 4.1
23.4	−1.7	+.5	25.8	24.1	26.3	2.2	.7
23.4	−1.2	+1.4	26.0	24.8	27.4	2.6	1.4
24.1	−1.6	----	26.7	25.1	26.7	1.6	1.0
24.1	−1.2	+.7	26.2	25.0	26.9	1.9	.9
19.4	−4.7	----	25.2	20.5	----	----	1.1
19.4	−4.0	----	25.2	21.2	----	----	1.8
21.6	−1.5	+3.1	25.2	23.7	28.3	4.6	2.1
21.1	−1.5	----	25.2	23.7	----	----	2.6
21.0	−2.2	1.2	23.8	21.6	25.0	3.4	.6
21.2	−2.5	+1.3	25.0	22.5	26.3	3.8	1.3
January							
+2.0	−16.9	----	20.0	3.1	----	----	1.1
−0.8	−10.4	----	11.2	0.8	----	----	1.6
−0.7	−8.0	----	8.0	0	----	----	.7
−1.0	−6.8	−3.8	7.2	.4	3.4	3.0	1.4
−0.7	−6.2	−3.9	7.4	1.2	3.5	2.3	1.9
+0.5	−1.7	----	3.7	1.5	----	----	1.0
+0.5	−8.1	----	8.7	.6	----	----	.1
+1.0	−5.5	−3.9	6.9	1.4	3.0	1.6	[2] .4
+5.0	−2.5	----	8.6	6.1	----	----	1.1
+5.0	−2.7	----	8.1	5.4	6.4	1.4	[2] .4
Mean	----	----	----	----	----	2.8	1.2

[1] Only 1 minute after previous observation. [2] Low radiation intensity.

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Compiled by C. F. TALMAN

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SUBSIDENCE IN MARITIME AIR OVER THE COLUMBIA AND SNAKE RIVER BASINS

By ARCHER B. CARPENTER

[Weather Bureau, Portland, Oreg., October 1935]

The Columbia and Snake River Basins are surrounded by the Rocky Mountains to the northeast, east, and southeast; a high plateau to the south; and the Cascade Range to the west. In addition to this almost continuous rim that surrounds the combined basins, there is the ridge of the Blue Mountains between them. The most notable and most effective outlet for this great area is the Columbia River Gorge.

The period covered in the present study extended from January 19 to February 10, 1935; and the problem investigated is that of subsidence in the maritime air associated with low stratus clouds and fog. This type of stagnation is not uncommon in the Columbia River Basin east of the Cascade Range, but it is less common for the effects of this stagnation to reach over into the Snake River Basin, and to be persistent for such a long period. These weather effects are easily seen on the short-period airway weather maps prepared at Portland, Oreg. This study is based on these maps in conjunction with the large Map A; airplane soundings at Seattle, Spokane, and Billings; "weather logs" from pilots of the air lines; and

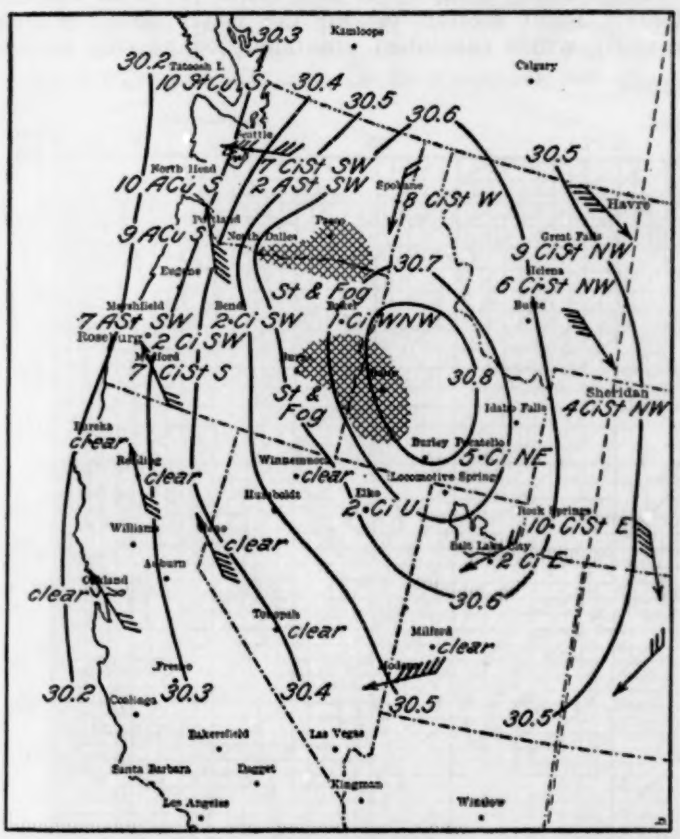

FIGURE 1.—February 2, 1935, 1 p. m. Mean sea-level isobars, winds at 8,000 feet, and high cloud movements.

associated data. The air-mass names are those used by Willett (1), and the references to subsidence are intended to follow the lines suggested by Namias (2).

The entire far western part of the United States received precipitation in the few days prior to January 19. By this time, the last of a series of disturbances had moved into Utah from the Oregon coast. This particular direction of movement is favorable to development of stagnation in the drainage areas of the Columbia and Snake Rivers. The air mass that followed was characteristically polar Pacific (P_P), with showers over Washington and parts of Oregon for several days. No airplane observations were available in this air mass to further identify it. Surface radiation and air drainage in the Columbia River Basin produced the first patches of fog and low clouds on the east slope of the Cascade Range on the morning of January 24. These fog patches increased

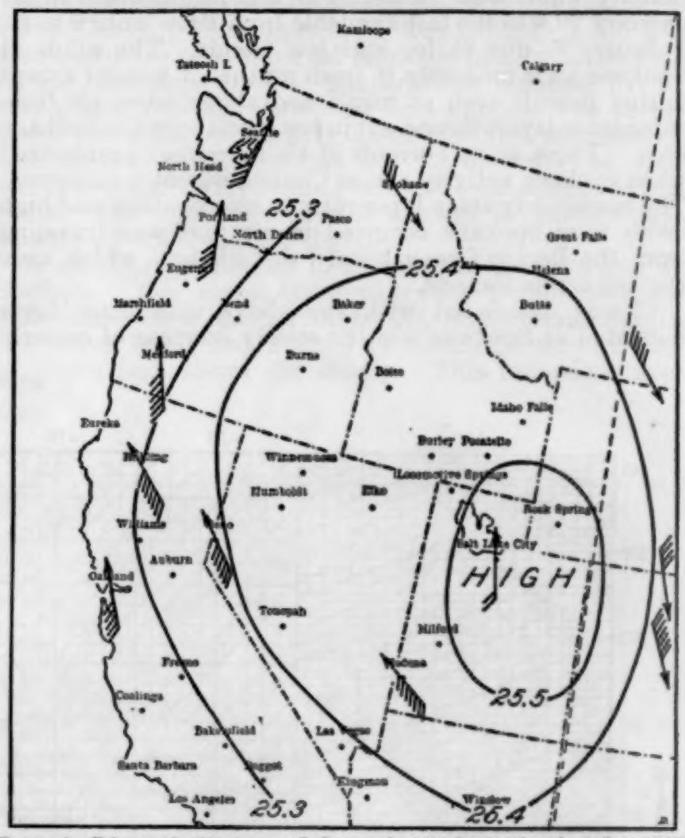

FIGURE 2.—February 2, 1935, 1 p. m. Isobars at the 5,000-foot level, and winds at 14,000 feet.

in size and duration on the succeeding mornings, with light fogs also forming in the Boise area on January 25 and 26, and with dense fog reported from Boise on the 27th. By January 28, the air mass over the Columbia and Snake River Basins had become sufficiently stable for dense valley fogs to continue throughout the day. Mixed local smoke and fog formed at Salt Lake City each evening, and became an increasing hazard to aviation in the days that followed.

It is difficult, without airplane soundings from Boise or Salt Lake City, to show subsidence in the air mass with its dome apparently located over this area. This location for the dome top is based on the relation between the sea-level pressures, with high pressure centered near Boise, and the 5,000-foot pressures with a center east of Salt Lake City. Upper air winds at 8,000 feet indicate the center just north of Salt Lake City, and the winds at 14,000 feet indicate the center between Salt Lake City and Rock Springs (figs. 1 and 2).

Since this study is necessarily based on data available at Portland, Oreg., an attempt will be made to prove subsidence in this air mass, with the information available. On January 23, a low inversion was evident over the Pendleton-Pasco area. This was apparently the beginning of subsidence. Radiation from the surface, and air drainage into this area, had already begun. From January 24 to 29, this cold surface layer, and the warm layer above, both became deeper and deeper, as evidenced by temperature reports from air-line pilots (fig. 3). On January 29, this warm layer became apparent in the low levels of the Spokane sounding (fig. 4). The layer between 1.2 and 1.9 kilometer was both warmer and drier than on the previous day. The winds in this layer were light southeasterly, and were a part of a similar deepening layer of light southeasterly winds over Boise. The 9 a. m. balloon run for January 29 was the last available from Boise until 9 p. m. February 5, due to fog and low clouds. The winds at Spokane were moderate to fresh southwest to west except during periods such as mentioned above when air from subsidence layers flowed out in low levels over the Spokane area. These warm currents of air were most pronounced when cyclonic activity across Canada was at a minimum. The moderately steep lapse rates in intermediate and high levels over Spokane occurred in air that was traveling from the Pacific Ocean toward disturbances which were moving across Canada.

Closely associated with the above subsidence layer indicated at Spokane was the steady increase of easterly winds in the Columbia River Gorge, beginning with a total movement of 181 miles on January 24, and increasing steadily to a maximum total movement of 940 miles

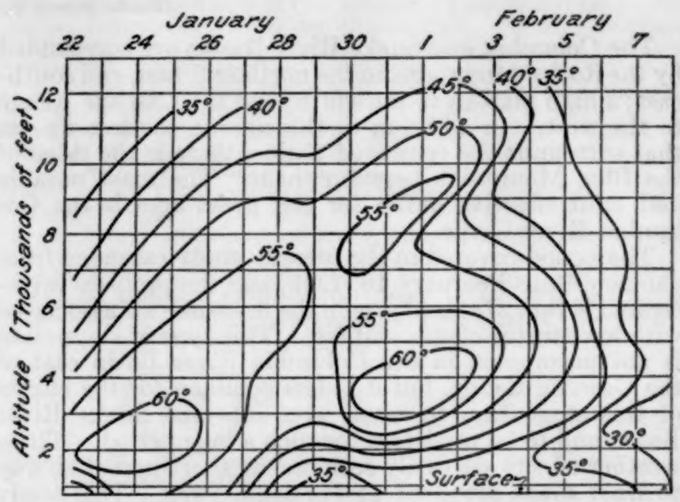

FIGURE 3.—Free-air temperatures (F.) over the Pendleton-Pasco area, January 23-February 8, 1935.

of easterly winds on January 29. This represents an average hourly velocity of 39.2 miles per hour for the Crown Point station (6) on the latter date. Strong easterly winds continued uninterrupted at this station

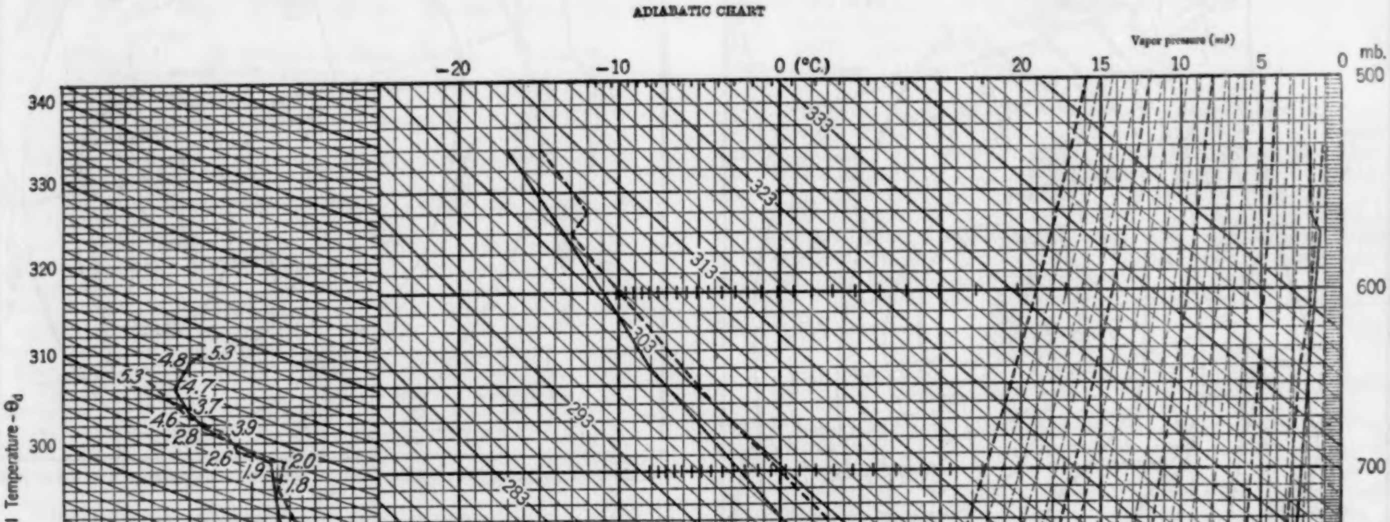

FIGURE 4.—Adiabatic charts for soundings at Spokane, Wash., with equivalent-potential-temperature diagrams, January 28 and 29, 1935. Shows stability of the air, and the beginning of subsidence.

until February 10. Total wind movement from the east was 10,673 miles for 18 days, or an average of 24.7 miles per hour. The average temperature in these easterly winds at Crown Point was approximately 40° F. (4.5° C.). This steady, strong flow of moderately warm easterly winds, for such a long period, was surely associated with subsidence in the air mass to the eastward.

On January 30, easterly winds set in at Government Camp and continued easterly until February 11, with light to moderate velocities. Government Camp is located on the south slope of Mount Hood in the Cascade Range, approximately 60 miles east-southeast of Portland, Oreg.

At Spokane on January 30, the southeast winds in the low levels had been entirely displaced by southwest winds with attendant lower temperatures. However, on January 31, the southeast winds from the subsiding air mass were again present, with higher temperatures and lower moisture content than on the previous days.

Evident at the top of the Spokane sounding for January 29, was an occluded front. This front was the only one of any consequence in this area of frontolysis to the south of Spokane. At Boise, pressure waves began with a maximum just before midnight a. m. January 29, and reached successive maxima at 4-hourly intervals, with the final maximum at 11 a. m. The pressure decreased 0.05 inch between each of the maxima. The winds were variable, with velocities from 3 to 5 miles per hour, but with no apparent relation to the pressure waves. Temperature changes were insignificant. Surface weather was dense fog until 7:30 a. m., then ground fog clearing slowly. Dense fog formed again in the evening under conditions identical with those of the previous evening, indicating no change in air mass at the surface or in the lower levels. The structure at intermediate levels appears to have been changed, with the beginning of two inversion layers instead of the one previously indicated by temperatures from air line pilots.

Evidence of the dome structure is found in the "weather logs" turned in by pilots of the air lines at the end of each trip. On February 3, the eastbound pilot reported the top of the fog layers at 3,000 feet (0.9 kilometer), in both the Columbia and Snake River Valleys. The next layer above the fog had a ceiling of 9,000 feet (2.7 kilometers) over Boise, and sloped down to a ceiling of 6,000 feet (1.8 kilometers) over Cascade Locks in the Columbia River Gorge. This upper layer was 1,000 to 2,000 feet thick, and the pilot reported an entire lack of turbulence in the clear layers. The temperatures reported by air line pilots over the Pendleton area indicate two inversions, one at approximately 5,000 feet (1.5 kilometers), and another at 11,000 feet (3.4 kilometers). In each case the cloud layers formed below the subsidence inversions. The upper inversion is evident in the Spokane sounding for February 3 (fig. 5).

A cloud layer did not form beneath the inversion at Spokane. The cloud layer over the Pendleton-Boise area indicates a sharper inversion, higher humidity in the cloud level, and a drop in humidity through the inversion just above the clouds. This inversion layer

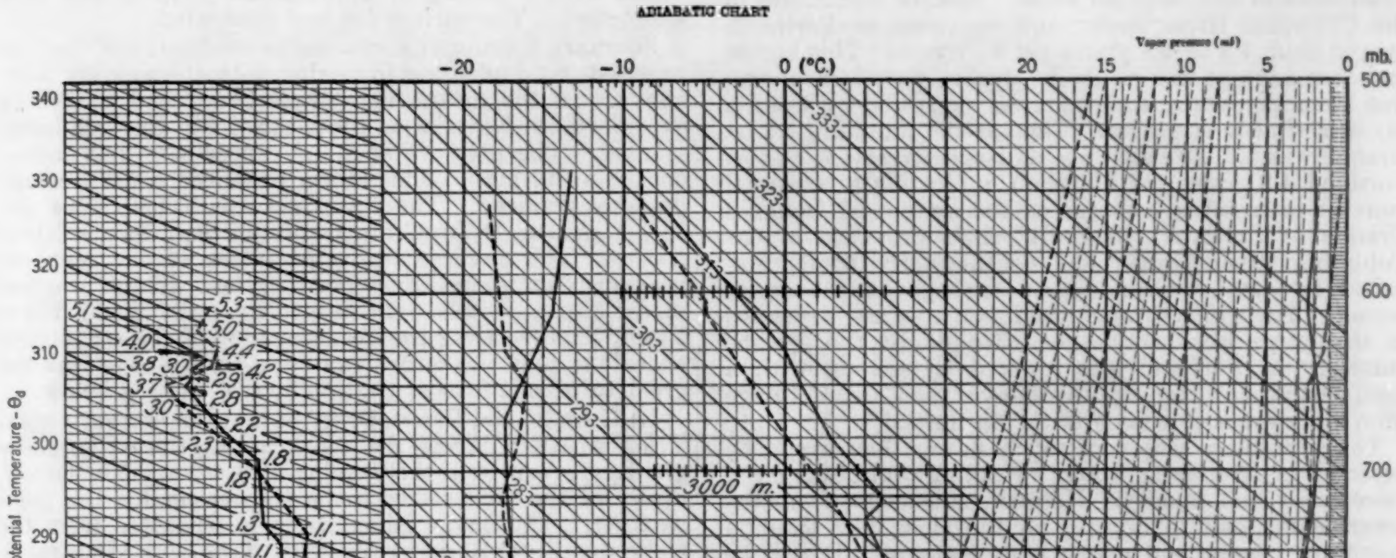

FIGURE 5.—Adiabatic charts for soundings at Spokane, Wash., with equivalent-potential-temperature diagrams, February 2 and 3, 1935. Shows subsidence.

is quite similar to one over Cleveland, Ohio, on October 7, 1932, described by Namias (**2**) as follows:

> From the sharp drop in humidity through the upper inversion it is clear that the *Tp* air is certainly not actively ascending the frontal surface, and it is probable that the colder air below the inversion is retreating at a faster rate than the warm *Tp* air is advancing. This velocity distribution characterizes the discontinuity surface as a surface of subsidence, despite the fact that the discontinuity separates two different masses of air.

The day and night continuation of fog and low stratus is a good indication of subsidence. Namias (**2**) states that—

> Subsidence inversions are generally of greater intensity than ordinary radiation inversions, and since some subsiding motion is usually continuing, it is manifest that these low subsidence inversions are not completely wiped out during the day. This is in contrast to those due entirely to radiation.

The above is substantiated by the unchanging moderate to strong easterly winds in the Columbia River Gorge, and by the easterly winds passing over the Cascade Range from warm subsidence layers. Very light changeable winds were reported in the fog and stratus areas beneath the inversion. Temperatures from air line pilots indicate the continuance of a decided inversion throughout the daytime hours (fig. 3).

The specific humidities on January 31, at the stations of Boise, Baker, Bend, Burns, Lakeview, Winnemucca, Elko, Salt Lake City, Pocatello, and Helena were all between 3.2 and 4.1 grams per kilogram. Seven of the 10 stations agreed within 0.4 grams per kilogram. This close agreement of the specific humidities was notable from January 29 to February 5, indicating stagnation and subsidence in one large air mass. Specific humidities in the Columbia River Basin, and westward to Portland, ranged from 4.5 to 4.8 grams per kilogram. This higher moisture content was no doubt due in part to evaporation from the warm, moist soil, as suggested by Counts (**3**) in a similar situation. The specific humidity at La Grande was 4.2, at Pasco 4.5, at Hood River 4.7, and at Portland 4.8 grams per kilogram, indicating a continual increase in moisture content as the air flowed from La Grande to Portland. Easterly winds prevailed in the Columbia River Gorge, and southeasterly winds prevailed in the La Grande area throughout the entire period. The winds through the Pasco area and westward to the gorge were very light. No doubt the specific humidity at Portland was lowered by mixing with a southeast air flow coming directly over the Cascade Range from an intermediate layer of the air mass.

The subsidence was very much slower than would be expected in other areas, where spreading could take place more easily and rapidly. Here the subsidence from the lower layers had to depend on the slow flow through mountain passes, and across high plateaus. It will be noted that subsidence layers, when indicated in airplane soundings, were usually at low levels, because the airplane stations were located around the periphery of the dome. High pressure was usually centered over the Snake River Basin in Southern Idaho.

Further evidence of subsidence in this air mass is found in the general weather sequence for the northwestern section of the United States including Idaho, Montana, Wyoming, Colorado, Utah, Nevada, Oregon, and eastern Washington. The above includes an area with a radius of approximately 500 miles from the center of the subsiding air mass. On January 28, at 5 a. m., generally cloudy weather prevailed over this area. On the following day, clear skies covered most of the area, except for the fog and stratus areas in the Columbia and Snake River Basins. This clearing would be expected in a subsiding air mass with no appreciable change in pressure distribution at the surface. By January 30, clear skies prevailed at nearly every station in the above area, and in the following 5 days clear weather also spread slowly eastward across the United States. The clear weather was no doubt a result of the combined subsidence and frontolysis.

Closely associated with the above, is the absence of precipitation over the same area. Twenty-four of the twenty-six regular Weather Bureau stations had no precipitation during the period from January 25 to February 5. The remaining two stations, on the western and northern extremities of the area, had a total of 0.09 inch. This precipitation occurred before the stations were affected by subsidence in the air mass under consideration.

At Spokane, it is interesting to note the fog layers which formed beneath the lower inversion on the mornings of February 4 and 5. These were the only occasions on which the deeper fog layer in the Columbia Basin spread that far to the northeast, and this was due to increased diathermancy of the air mass above.

On February 5, *NPP* air moved in over the Columbia River Basin above an elevation of 1.7 kilometers, as evidenced by airplane soundings at Spokane (fig. 6). This same mass of *NPP* air was evident in the Seattle sounding on the previous day. During the day, February 5, the fog layer at Pasco began to show signs of weakening, probably because of a small amount of mechanical mixing with the new layer above. Near midnight of the 5th, the cloud top at Pasco was 3,300 feet (1 kilometer) above sea level, and it was 1,800 feet (0.5 kilometer) thick, with a ceiling of approximate y 1,100 feet (0.4 kilometer). The surface fog had dissipated.

February 6 brought a noticeable weakening of the low overcast, no doubt due to mixing with the new air mass above. In the meantime a disturbance had moved in over northern Nevada, on the south rim of the area being studied. The pressure at Winnemucca was 29.8 inches on the a. m. map. This storm produced a north-south pressure gradient. The first effect was to help draw out the stagnant air from the Columbia and Snake River Basins. This favored the importation of the *NPP* air previously mentioned over Washington. In the progress of the storm, clouds were formed over the Snake River Basin, thus reducing the diathermancy of the air to such an extent that the return radiation from above was too great to permit further continuance of the fog below.

La Grande, and Baker, Oreg., enjoyed persistently good flying weather during the southeast-northwest pressure gradient previous to the evening of February 5. Topography of the area seems to be the reason for the good weather. The Snake River Basin is separated from the Columbia River Basin by the ridge of the Blue Mountains, except for the narrow, deep gorge of the Snake River, which in itself is not sufficient to carry off any material volume of air flow.

This makes it necessary for the surface air flow to seek other channels, and it spills over into the valley surrounding La Grande. From there it finds an exit through the valley of the Grande Ronde River into the lower reaches of the Snake River, and finally flows out into the Columbia River Basin. The major subsidence taking place over the Snake River Basin had to find a way out, and La Grande benefited. Surface temperatures at La Grande were higher than those in the Snake River Valley, due to turbulent mixing with the warmer air above. Pilot logs with such reports as "Very rough vicinity La Grande, smooth otherwise", were indicative of conditions at this time. It has been noted that these southeast

surface winds at La Grande are sometimes a better indication of pressure gradient than are the sea-level isobars for this area.

Another noticeable effect of subsidence in the air mass with its main body over the Snake River Basin is the fair weather produced in the coastal valleys. From 1 p. m. January 24 until 9 p. m. February 10, Portland, Oreg., had only 0.02 inch precipitation. Average temperature at Portland from January 22 to February 11, inclusive, was 8.5° F. above normal. The cumulative departure was plus 178° F. Associated with this fair weather was the average pressure gradient of 0.31 inches directed from Boise toward Portland during the period. The normal pressure gradient from Boise to Portland for the 3 winter months is 0.06 inch.

The above findings lend support to the theory, advanced by B. S. Pague (**4**), that dynamic heating plays an important part in the warm climate of this area. These findings also agree with the following statement by Byers (**5**) in reference to weather of the Pacific coast: "Since nearly all the air which moves out over the ocean from the interior is a return current of maritime air and rarely continental, this kind of mountain modification is important in a study of coastal weather." The history of the air mass, the temperatures in the inversion layers, and the specific humidities, all indicate a previous maritime history as suggested by Byers in the above statement.

In summarizing this study it appears that the fairly common winter high-pressure area, centered over southern Idaho, is intensified by cooling in the lower levels of a large mass of stagnant maritime air. This cooling in the low levels is productive of low stratus clouds and fog in the Columbia River Basin, and later in the Snake River Basin, if the stagnation continues. Foehn-heated currents of air from intermediate subsidence inversions, flowing westward over the Cascade Range into the coastal valleys, play an important part in the warm climate of the Pacific coast.

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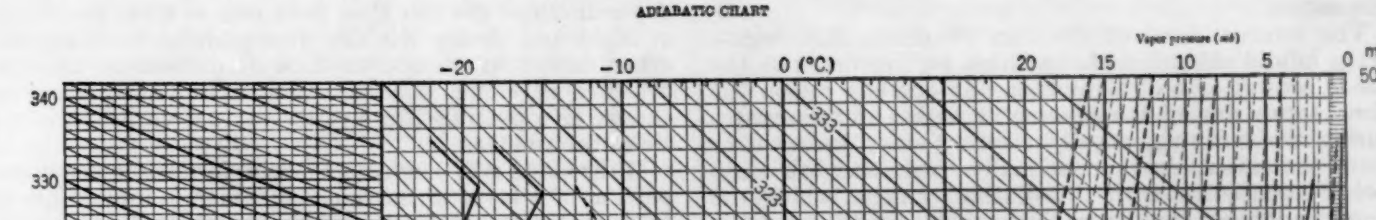

FIGURE 6.—Adiabatic charts for soundings at Spokane, Wash., with equivalent-potential-temperature diagrams, February 4, 5, and 6, 1935. Shows air-mass changes resulting in the breakdown of the system.

THE DIURNAL VARIATION IN CEILING HEIGHT BENEATH STRATUS CLOUDS

By EDWARD M. VERNON

[Weather Bureau, San Francisco, Calif., January 1936]

The diurnal changes in various meteorological elements have been the subject of careful investigation for many years. The diurnal tendencies of pressure, temperature, and wind have received more attention than those of the other elements, and are generally recognized and understood. The increasing demand for accurate forecasts of ceiling and visibility placed upon forecasters by commercial aviation interests has directed attention to the desirability of considering the diurnal tendency in the elevation of stratus cloud and fog when formulating airway forecasts.

During a study which was begun in an attempt to arrive at a reliable method for forecasting the diurnal changes in ceiling height beneath stratus cloud and fog in the San Francisco Bay region, some interesting observations were made which have resulted not only in a better knowledge of the ceiling height changes, but also in a clearer conception of the processes involved and in increased ability accurately to forecast the time of formation and dissipation of the cloud in the region in question.

The results of the study are here presented, in the hope that some of the precepts derived for forecasting the behavior of stratus cloud and fog might be applicable in some degree to other regions and therefore helpful to forecasters.

The stratus cloud of the San Francisco Bay region is the inland extension of the "high fog" common to the entire coastal area of California. In the bay region the cloud forms during the evening or night, and dissipates during the morning, usually clearing away by noon or soon thereafter, but occasionally persisting all day. Before proceeding with the diurnal changes which the cloud undergoes it is desirable to touch briefly upon the air mass structure and the processes involved in its formation.

During the summer, when the cloud is most common, a remarkably homogeneous stratum of cool, moist air overlies the bay region as well as the other coastal areas of California. This air, obviously of maritime origin, is fed into the coastal regions from the semipermanent Pacific HIGH which reaches its maximum strength during the summer. Overlying the moist stratum, at an altitude ranging from less than 1,000 to more than 2,500 feet, is found comparatively warm and very dry air. The surface of discontinuity between the two air strata is manifested as a very sharp temperature inversion. While the temperature increases sharply with increase of height at the inversion level, the relative humidity decreases. The strength of the inversion is so great as to prevent an appreciable amount of mixing of the two strata.

The stratus cloud forms entirely in the moist stratum, usually just below the inversion level. Although referred to as stratus, the cloud actually begins as many incipient cumuli. As they increase in extent, the cumulus masses merge to form the cloud sheet which, for observational purposes, is usually classed as stratus. According to Bowie[1] the predominating factor in the formation of the cloud is the radiational cooling which occurs near the upper surface of the moist stratum. He explains that air rich in water vapor is selectively highly absorptive and likewise selectively highly radiative of terrestrial radiation; and that, conversely, dry air is diathermanous to such radiation. This leads to pronounced cooling near the upper surface of the moist stratum, causing instability and finally cloud formation. If this theory be correct we should expect to find the lapse rate in the moist stratum to be equal to or in excess of the dry adiabatic. That the cloud begins to form as a cumulus tends to indicate such a lapse rate, and, as we shall see later, the relation between the cloud height and the surface relative humidity tends also to bear out the theory.

Some authorities prefer to place mechanical turbulence ahead of radiation as the predominant factor in producing the cloud. That turbulence does not control the diurnal changes which the cloud undergoes is brought out effectively by a comparison of figures 4 and 5, showing a minimum of cloudiness occurring simultaneously with a maximum of wind movement, and vice versa. Perhaps each of the two factors plays its part.

Figures 4 and 5 also tend to discredit the idea that the cloud simply drifts in from over the ocean.

Furthermore, an examination of the specific humidities in the bay region during almost any period in which stratus cloud forms at night and dissipates during the day will reveal the fact that the air-mass types prevailing at night and during the day do not differ from one another except in respect to thermal differences and the presence of cloud, thus definitely eliminating air-mass change as a possible cause of the diurnal variation in the cloud occurrence.

If the cloud is of convective origin, forming in the upper portion of a layer of unstable air which is limited above by an inversion through which convection cannot penetrate, it should be expected that a very definite relation would exist between the altitude of the base of the cloud, i. e., the ceiling height, and the depression of the dew point of the surface air. More specifically, there should be about 225 feet of ceiling for each degree of depression of the dew point. In order to test for this condition, the average amount of ceiling height for each degree of depression of the dew point was computed for each hour of the day. Records for a period extending over 5 summer seasons were used for this purpose. The averages are shown in figure 2. It is significant that at 5 a. m., about the hour of sunrise, there are on the average 227 feet of ceiling for each degree of depression of the dew point. This remarkable agreement between theory and the observed ceiling heights strongly indicates a lapse rate at least equal to the dry adiabatic, with complete interchange of air between the ground and cloud levels.

An increase in the surface temperature causes an increase in the depression of the dew point and therefore an increase in the amount of vertical displacement necessary to cause saturation; in other words, an increase in surface temperature raises the saturation level. With a convective condition prevailing, such an increase in saturation level must be followed by a rising ceiling. That the temperature rises during the morning hours, even though the sky is overcast, is shown in figure 3, which gives the average hourly temperature. These averages are based only on temperatures observed beneath a sky from six- to ten-tenths overcast with stratus cloud. It appears that no influence other than the in-

[1] Bowie, E. H. The Summer Nightime Clouds of the Santa Clara Valley, California. MONTHLY WEATHER REVIEW, February 1933, pp. 40-41.

coming solar radiation can be responsible for the rise in temperature. The inflow of warm air from regions not covered by the cloud does not seem possible and is not observed. In connection with the effect of the sun upon clouds, Sir Napier Shaw [2] states that clouds in general have very little to fear from the sun because so large a part of the solar energy which strikes them is reflected, while the small portion of it which is absorbed is in part radiated back to the sky and thereby lost. The logic of his statement is supported by the fact that observations of the upper surface of the bay-region stratus cloud have revealed that the altitude of its upper surface changes but little, although exposed to the direct sunlight.

About 78 percent of the solar radiation incident at the upper surface of the cloud is said to be reflected and thereby lost. A part of the remaining 22 percent penetrates the cloud, and probably goes largely to increasing the air temperature near the ground. Such an increase in temperature causes an increase in the saturation level and, therefore, in the ceiling; it often leads to complete dissolution of the cloud when the saturation level is so increased as to become higher than the inversion. This leads to the somewhat paradoxical statement that the sun, while beating down upon the upper surface of the cloud, evaporates it progressively from the base upward and not from the top downward.

Summarizing: thus far it has been found that the cloud may be considered to form in an unstable air mass limited above by an inversion through which convection cannot penetrate, and that it is dissolved by a similar process during the period of the day when the saturation level is increasing. This knowledge has resulted in improved ability to forecast accurately the time of formation and dissolution of the stratus cloud in the bay region. It is readily apparent that the cloud cannot form until the temperature has decreased enough to lower the saturation level to or below the inversion level. Again, during the daytime, complete dissolution can occur only when the increase in surface temperature has raised the saturation level to or above the inversion level.

This principle forms the fundamental basis for forecasts of the diurnal behavior of the cloud. However, full advantage of its value has probably not been obtained, due to lack of precise information on the height of the inversion at various periods of the day. In the absence of such information, the pressure difference between Oakland and Eureka has been used, for correlation purposes, as a substitute for the height of the inversion, because the pressure difference is roughly proportional to the height of the inversion. This fortunate relation is due to the fact that during the summer season the pressure over Oakland and Eureka is about the same at the same altitude in the warm air above the inversion level; therefore, differences in the sea-level pressure at the two stations are caused by differences in the density and depth of the layer of maritime air overlying the respective stations. With Eureka on the immediate coast and the depth of the overlying maritime air subject to only small changes there, the larger changes in the pressure difference between the two stations are closely related to the changing depth of maritime air over Oakland.[3] Correlation of these three elements, i. e., pressure difference between Oakland and Eureka, saturation level at Oakland based on surface temperature and humidity data, and the time of formation (or clearing) of the cloud, has given very good results. It must be expected, however, that when exact information on the height of the inversion becomes available, better results will ensue.

Returning to the analysis of the diurnal march of the ceiling height, it should be pointed out that the discussion which follows deals with a sky which is from six to ten-tenths overcast with stratus clouds. This is important because of the fact that the upper surface of the cloud is a most effective radiator of long wave-length radiation and an excellent reflector of solar radiation.

The idea that during the morning hours after sunrise the increase in surface temperature occurs first, and in turn gives rise to an increase in the saturation level and the ceiling height, is supported by the observed fact that the number of feet of ceiling for each degree of depression of the dew point decreases during this interval (fig. 2). This means simply that, with wind movement at its usual low value during the morning, the process of convection requires time to adjust the ceiling to the increasing saturation level, and that the rise in ceiling height therefore lags.

It appears that by 3 p. m. there is an excess of outgoing over incoming radiation, for at that hour both the temperature and the ceiling begin to decrease (figs. 1 and 3). By reference to fig. 2 it will be observed that there is still a lack of balance between the ceiling height and the depression of the dew point; i. e., the saturation level is still higher than the ceiling. This would lead us to expect the ceiling to continue to increase; that it does not continue to increase appears to be contradictory, but may be explained in the following manner:

After rising from the ground and reaching the upper surface of the cloud, the air begins to cool by radiation. Because of this cooling its saturation level becomes lower than before, with the result that when it sinks it brings the cloud level down below the saturation level indicated by the surface temperature and dew point. The difference between the saturation level of the air near the ground and that at the upper surface of the cloud during the late afternoon results in an irregular and often a broken cloud stratum. As the surplus of heat near the ground is gradually disposed of, the ceiling lowers and becomes increasingly uniform, with the result that by morning there is created a cloud sheet with a quite uniform ceiling at almost exactly the height which the depression of the dew point would lead us to expect.

The lowest ceiling occurs normally at about 3 a. m., while the average amount of change from midnight until sunrise is quite small (fig. 1). From the foregoing explanation of the diurnal behavior of the ceiling it would at first appear that the lowering tendency should always continue until sunrise. That it does not do so can be explained by the well-known insulating effect of a thick cloud layer. This effect is so well demonstrated by the nocturnal behavior of the stratus cloud that it seems worthy of brief discussion here:

So long as the cloud stratum is broken, and even while quite thin although solidly overcast, a considerable amount of terrestrial radiation passes directly outward to the sky without being absorbed by the cloud. As the ceiling continues to decrease, the cloud undergoes a proportionate increase in thickness because the upper surface does not decrease in altitude. Eventually the cloud becomes thick enough to be practically opaque to terrestrial radiation, restricting the outward flux of radiant energy to the amount radiated from its upper surface. When this occurs, a balance may soon be reached between

[2] Shaw, N. Manual of Meteorology, vol. III, pp. 181–182.
[3] For a thorough explanation of the method for computing the depth of a sea breeze refer to Humphreys, W. J., Physics of the air, pp. 108–110.

the amount of radiant energy supplied by the ground or undersurface and that disposed of by the upper surface of the cloud; this of course results in an unchanging ceiling.

Occasionally the sharp inversion characteristic of the bay region stratus cloud is replaced by a transitional layer between the two air strata; in such cases the cloud thickens both at the upper and lower surfaces. When the

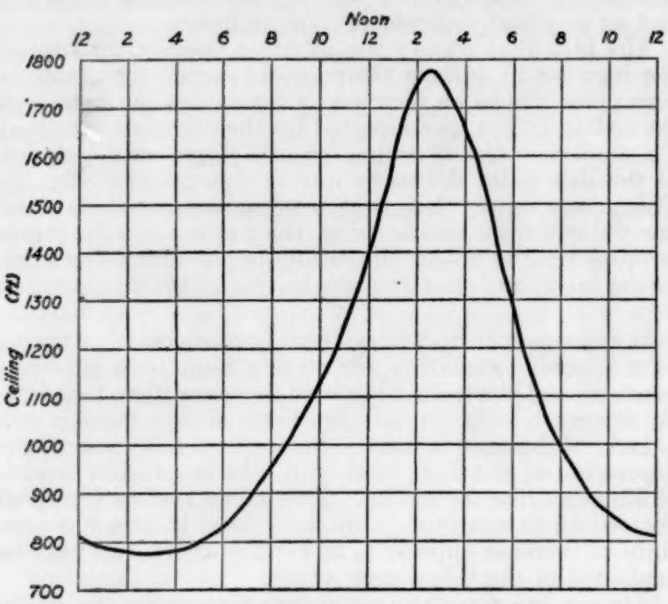

FIGURE 1.—Average hourly ceiling height at Oakland, Calif., during prevalence of stratus cloudiness.

upper surface of the cloud continues to build up after a balance between the radiation supplied by the ground and that disposed of by the cloud has been reached, the ceiling will also rise. This occurs even at night. The influx of a deeper layer of maritime air which permits the top of the cloud to build up to a greater height causes a similar increase in the ceiling height, provided the insulating

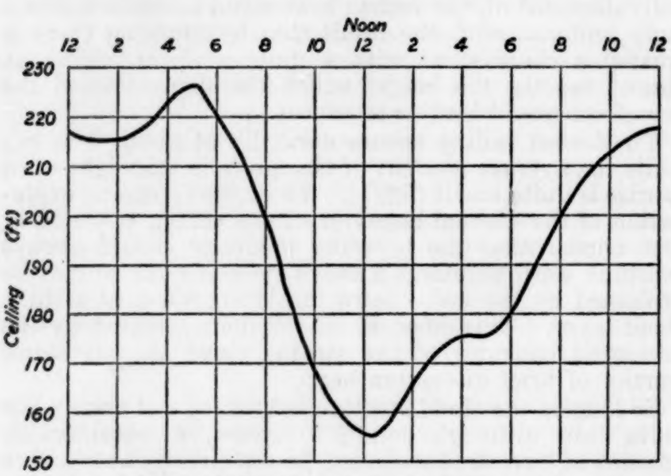

FIGURE 2.—Amount of ceiling for each degree of depression of the dew point.

thickness and radiational balance have already been reached.

In conclusion, it is believed that the principle brought out in the preceding paragraph should find a wide application in the forecasting of the elevation of stratus cloud and fog in various regions, regardless of whether the cloud or fog be associated with a stable or an unstable lapse rate. It may be summarized as follows:

1. If a stratus cloud or a fog of sufficient thickness to be practically opaque to terrestrial radiation overlies ground or any other undersurface the temperature of which is high as compared to the radiating surface of

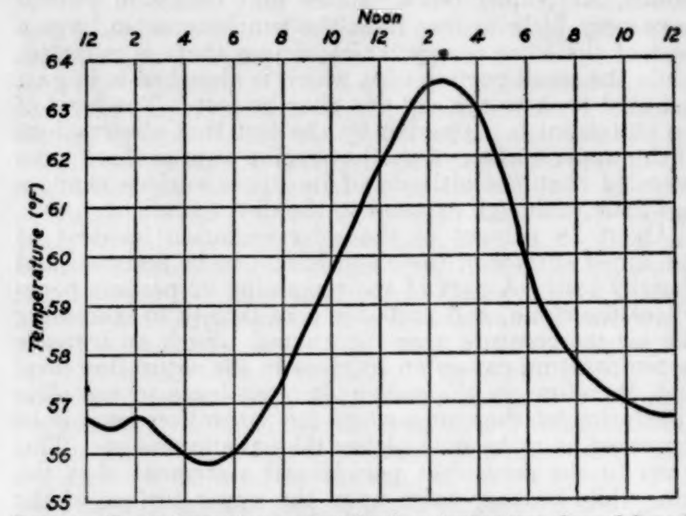

FIGURE 3.—Hourly temperature averages based on temperatures observed beneath broken-to-overcast stratus clouds at Oakland, Calif.

the cloud or fog, there will be a tendency toward rising ceiling; this tendency will continue so long as the supply of heat in the undersurface is maintained or, at night,

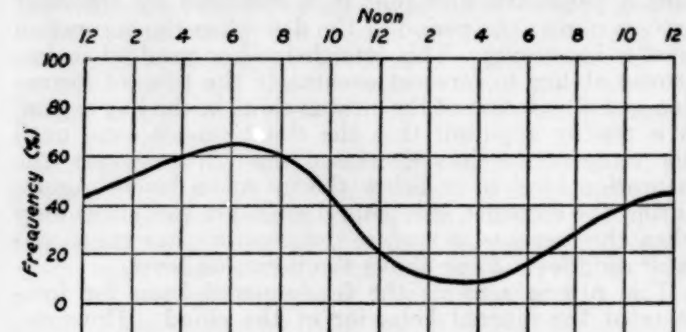

FIGURE 4.—Average hourly frequency of broken-to-overcast stratus cloudiness at Oakland, Calif., expressed in percentage of possible number of times observed.

until the cloud or fog becomes too thin to insulate against direct loss of terrestrial radiation.

2. If a stratus cloud or a fog of any thickness overlies an undersurface the temperature of which is low as com-

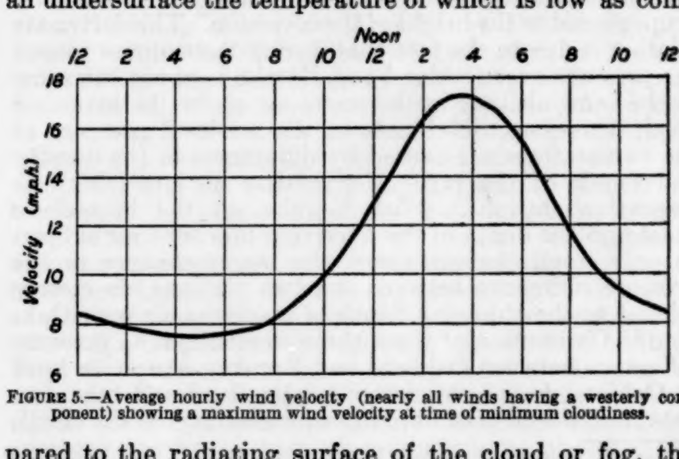

FIGURE 5.—Average hourly wind velocity (nearly all winds having a westerly component) showing a maximum wind velocity at time of minimum cloudiness.

pared to the radiating surface of the cloud or fog, the latter will dispose of radiant energy more rapidly than it is supplied by the undersurface and there will result a tendency toward decreasing ceiling.

GROUND TEMPERATURES COMPARED TO ROOF TEMPERATURES

By B. R. LASKOWSKI

[Weather Bureau, Huron, S. Dak., March 1935]

To determine what relation, if any, exists between the temperature of the air on the tops of high buildings in the congested sections of large cities and that near the ground out in the suburbs, is the object of the present study, which covers daily records for a period of 10 years, from October 1924 to September 1934.

The observations were taken in Topeka, Kans. The Weather Bureau equipment, used as one station, was located 100 feet above the ground level, on a building in the center of the business section. The second station was over a grass plot in the open, about 1½ miles west of the first. The intervening country is only slightly rolling so that the topography did not affect the readings. The instruments in both cases were housed in standard shelters which, by their louvered sides and double deck roofs, secure both free circulation of the passing air and the exclusion of heat by extraneous radiation, direct or reflected. It should be mentioned here that during the last year and a half of this set of readings the Weather Bureau instruments were about 20 feet lower, owing to moving into the new Federal Building, just across the street from the former location.

The Weather Bureau values of highest and lowest temperature are for the period from midnight to midnight. The ground readings were taken each evening about sunset, after the highest temperature for the day usually had occurred. In this connection one might ask what difference taking one set of readings from midnight to midnight and the other from sunset to sunset could make. There were occasions when the midnight readings on the roof had to be taken as either the maximum or the minimum for the following day. As a rule the same held true for the readings taken at sunset. However, these instances were so evenly divided throughout the period that the error resulting from this discrepancy presumably has not materially affected either the monthly or annual means. For more information in regard to the effect of the time element in the taking of temperature readings, the following papers covering this question will be found very interesting: "The limits of the day as affecting records of minimum temperatures", by E. S. Nichols in MONTHLY WEATHER REVIEW, September 1934; and "The effect of time of observation on mean temperatures", by W. F. Rumbaugh in MONTHLY WEATHER REVIEW, October 1934. In commenting on the two sets of temperature readings herein, one will be designated the ground set and the other the roof set.

The results of the study are shown in the five brief tables herewith.

During the period covering these comparative observations, some of the lowest readings ever recorded in this vicinity occurred, as well as the highest.

By examining the means in table 1, we find that the popular opinion that it is much cooler near the ground is not a fact as far as average temperature is concerned. In this study we find that for the entire period the average temperature at the ground was 56.5°, and 55.8° on the roof. There were individual months when the roof readings exceeded those on the ground; but there was no regularity in their occurrence.

Table 2, mean maximum temperatures, shows that the ground exposure averaged 1.7° above that of the roof for the period.

Table 3, mean minimum temperatures, shows that the ground readings generally were below the roof readings for the period, averaging 0.5° lower.

Table 4, highest readings, shows that these values, like the mean maximum temperatures, varied from one place to the other, but, as a rule, read closely together. This probably is owing to the fact that when the air is warmest it is very thoroughly stirred up. Thus, on August 3, 1930, the readings at the ground and on the roof agreed at 110°. Again, in the year 1934, July 15, the ground reading was 110° and the roof record 111°; and on August 10 when the ground indicated 111°, it was 112° on the roof.

Table 5, lowest readings, shows the greatest differences, a result due to the more rapid cooling at the ground surface than on the roof of a building. Radiational cooling on the ground is more rapid when the wind movement is light and permits the air mass to become stagnant. Several dates picked at random are here selected to illustrate this: On April 26, 1926, with an average wind movement of less than 6 miles per hour, the minimum on the ground was 37°, 5° lower than on the roof. On September 15, 1928, with an average wind movement of 3.3 miles per hour, the ground temperature registered 54°, and the roof reading was 61°. On November 1, 1929, with less than 5 miles of wind movement, the ground reading was 29°, 5° lower than the roof reading. It will be observed from this that differences of this kind may be obtained at any time of the year. A snow-and-ice cover is another cause of more rapid cooling at the ground surface. During the period January 12 to 16, 1927, several inches of snow accumulated on the ground on the 12th and 13th. Very little remained on the roofs by the evening of the 13th. On the 14th the ground reading was 5°, and the roof 8°. On the 15th the ground read 14° below zero as compared to 9° below zero on the roof. On the 16th the ground minimum was 16° compared to 23° on the roof. Again, consider the period January 22 to 25, 1930: The snow cover had accumulated up to the 22d. On the morning of the 22d there was a ground reading of 19° below zero compared to 13° below zero on the roof. On the 23d the ground reading was 7° below zero, but it was 1° above zero on the roof. On the 24th the record was 9° on the ground, 12° on the roof; and on the 25th, 3° on the ground and 11° on the roof.

The lower night readings on the ground resulted in the daily range of temperature averaging greater at the ground. The largest differences in this connection occurred during quiet spells when the radiation effect was greatest.

SUMMARY OF COMPARATIVE READINGS

[10-year record]

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
TABLE 1													
Means:													
Ground	31.0	37.8	44.6	57.4	65.5	75.6	81.0	78.1	71.1	57.9	44.5	33.7	56.5
Roof	30.4	37.0	43.2	56.1	64.9	75.1	80.5	77.7	70.3	57.6	43.6	32.7	55.8
TABLE 2													
Mean maximum:													
Ground	41.4	49.5	56.8	69.6	77.3	87.1	92.8	89.8	82.6	69.5	55.7	44.0	68.0
Roof	39.6	47.1	53.9	66.6	75.6	85.7	91.3	88.6	81.0	68.0	53.6	41.7	66.1
TABLE 3													
Mean minimum:													
Ground	20.5	26.0	32.4	45.2	53.7	64.2	69.1	66.3	59.6	46.3	33.3	23.5	45.0
Roof	21.2	27.0	32.4	45.6	54.2	64.5	69.7	66.9	59.7	47.2	33.7	23.8	45.5
TABLE 4													
Highest temperature:													
Ground	71	83	89	93	100	104	110	111	102	93	83	70	111
Roof	69	83	88	93	103	106	111	112	102	93	84	70	112
TABLE 5													
Lowest temperature:													
Ground	−19	−15	0	14	34	46	51	49	35	16	4	−10	−19
Roof	−13	−14	4	17	35	49	52	52	38	16	8	−9	−14

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING JANUARY 1936

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal at all three Weather Bureau stations.

Table 2 shows an excess in the amount of total solar and sky radiation at all stations with the exception of Washington, Lincoln, Twin Falls, Riverside, and Ithaca. Beginning with this issue, departures from normal will be published regularly for Ithaca and Friday Harbor in addition to the departures from normal at most of the other stations. Similar departures for Pittsburgh, La Jolla, Mount Washington, and San Juan cannot be published until sufficient records are obtained to establish normals.

Table 3 shows in general comparatively high turbidity factors for January; but, with the exception of the 13th, relatively low water-vapor content of the atmosphere on days when these measurements were made.

No polarization readings were obtained at either Washington or Madison, because of continuous snow or ice cover during the month.

TABLE 1.—*Solar radiation intensities during January 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Jan. 3	6.02			1.22	1.39		1.35	1.17			4.37
Jan. 10	3.45						1.18	.90			3.45
Jan. 13	5.36	0.75	0.82	.94	1.03			1.01	0.92	0.74	5.36
Jan. 14	3.45	.70	.75	.99	1.24			.70			3.00
Jan. 20	1.52	.90	.96	1.10	1.41		1.37	1.14	.97	.91	1.52

TABLE 1.—*Solar radiation intensities during January 1936*—Continued

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.—Continued

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Jan. 21	2.06			.77	1.23		1.36				2.06
Jan. 23	.66	.95	1.10	1.19	1.46		1.45				.66
Jan. 24	.64	.88	1.08	1.30	1.46		1.46	1.24	1.12	1.00	.56
Jan. 27	.58	.68	.86	1.00	1.18		1.11	.78			.66
Jan. 28	.91		.63	.76	1.05		1.12				1.07
Means		.81	.89	1.03	1.27		1.30	.99	1.00	.88	
Departures		+.06	+0.3	+.01	+.03		+.06	+.06	+.10	+.07	

MADISON, WIS.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Jan. 14	4.17		.73	.85							4.17
Jan. 23	.23		1.25	1.36	1.56						.38
Jan. 24	.23	1.09	1.23	1.34	1.52						.43
Jan. 30	.71				1.26						.81
Jan. 31	.51		1.16	1.28	1.49						.71
Means		(1.09)	1.09	1.21	1.46						
Departures		+.13	+.03	0.00	+.11						

LINCOLN, NEBR.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Jan. 4	1.78	1.07	1.23	1.30							2.16
Jan. 9	1.78		1.03	1.24				1.31	1.11	1.00	3.00
Jan. 13	1.88		.94	1.12							3.81
Jan. 16	1.78			1.20							1.32
Jan. 18	4.17		1.15	1.27				1.29	1.18	1.06	.79
Jan. 20	.71	.93	1.08	1.17							1.96
Jan. 21	1.32			1.28							.53
Jan. 22	.91			1.33				1.12	.98	.80	.53
Jan. 25	.38			1.24							.96
Jan. 27	.28			1.06	1.49						.66
Jan. 29	.48		1.17	1.35	1.41		1.41	1.22	1.14	1.00	.96
Jan. 30	.58		1.31	1.41	1.58		1.54	1.39	1.24	1.15	.86
Means		(1.00)	1.13	1.25	1.49		(1.48)	1.25	1.10	.98	
Departures		+.07	+.08	+.06	+.11		+.13	+.07	+.05	+.05	

* Extrapolated.

NOTE.—Since the data for Blue Hill, Mass., have not been received at the time of going to press, they will be included in the next issue of the REVIEW.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 1	132	106	66	48	73	153	20	6	147	274	301	157	259	133	58	71
Jan. 8	130	123	179	103	94	153	27	17	91	277	311	227	230	173	73	95
Jan. 15	126	152	210	82	125	277	33	13	157	278	302	256	262	187	65	130
Jan. 22	241	238	228	164	214	260	66	31	170	272	292	209	252	263	178	180
	Departures form weekly normals															
Jan. 1	−21	−23	−109	−33	−30	+7	....	−2	−18	....	+6	+2	+25	−16	−8	−29
Jan. 8	−22	−11	−6	+21	−14	−7	....	+7	−78	....	+11	+23	−15	+17	−3	−1
Jan. 15	−37	−4	+14	−17	+12	+92	....	−2	−27	....	+27	+47	−11	+5	−25	+9
Jan. 22	+61	+53	+2	+44	+60	+35	....	+5	−20	....	−40	+22	−28	+56	+80	+15
	Accumulated departures on Jan. 28															
	−133	+105	−693	+105	+196	+889	....	+56	−1,001	....	+28	+658	−203	+434	+308	−42

Atmospheric conditions during turbidity measurements

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during January 1936, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude		Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{y-r}}{1.94}$ (Percentage of solar constant)	$\frac{I_{m-r}-I_m}{1.94}$ (Percentage of solar constant)	w	Air-mass mass
Jan. 13	°	′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
2:48 a. m.	17	52	3.23	0.912	0.844	0.665	0.079	0.031	0.055	62.8	16.2	>40	N_{pp}
2:44 a. m.	18	22	3.15	.931	.846	.666	.074	.033	.054	63.6	17.1	>40	
Jan. 20													
0:52 a. m.	29	36	2.02	1.393	1.162	.933	.035	.020	.028	78.3	8.9	4.7	P_c
0:48 a. m.	29	47	2.01	1.393	1.162	.933	.035	.020	.028	78.3	8.9	4.7	
Jan. 21													
0:40 a. m.	30	19	1.98	1.266	1.099	.927	.100	.080	.090	66.6	4.4	1.2	N_{pc}
0:36 a. m.	30	27	1.97	1.268	1.100	.928	.100	.080	.090	66.6	4.2	1.2	
Jan. 23													
0:48 a. m.	30	22	1.97	1.461	1.273	1.017	.040	.010	.025	79.7	6.1	2.0	P_c
0:44 a. m.	30	32	1.96	1.461	1.273	1.017	.040	.010	.025	79.8	6.2	2.1	
Jan. 24													
1:24 a. m.	28	34	2.08	1.397	1.156	.991	.054	.040	.047	74.1	4.4	1.2	P_c
1:20 a. m.	28	51	2.07	1.461	1.204	.992	.054	.040	.047	74.2	4.2	1.2	
Jan. 27													
0:48 a. m.	31	20	1.92	1.190	1.060	.879	.120	.074	.097	66.4	6.9	2.6	P_c
0:44 a. m.	31	30	1.91	1.192	1.061	.880	.120	.075	.098	66.6	7.0	2.6	

Atmospheric conditions during turbidity measurements

Jan. 13. Temperature, 8° C., wind, NW. 12; visibility 12 miles. (No polarization during month; ground snow-covered.)
Jan. 20. Temperature, 3° C., wind, NW. 14; visibility 20 miles.
Jan. 21. Temperature, 5° C., wind, S. 8; visibility 20 miles.
Jan. 23. Temperature, 15° C., wind, NW. 15; visibility 30 miles.
Jan. 24. Temperature, 10° C., wind, NW. 12; visibility 50 miles.
Jan. 27. Temperature, 8° C., wind, NW. 14; visibility 30 miles.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Jan. 4													
2:53 a. m.	13	35	4.19	1.070	0.770	0.620	0.019	0.027	0.023	67.7	14.3	7.3	N_{pc}
Jan. 6													
2:53 a. m.	13	35	4.19	.770	.585	.485	....	....	....	....	....	....	N_{pc}, N_{pp} aloft
Jan. 8													
3:13 a. m.	12	21	4.61	.922	.706	.610	....	....	....	....	....	....	P_c
1:57 a. m.	20	14	2.88	1.260	.897	.746	.038	.050	.044	68.2	5.4	3.2	
0:28 a.m.	25	09	2.35	1.300	.925	.756	.046	.051	.048	71.4	6.6	4.3	
Jan. 10													
1:42 a. m.	22	52	2.56	1.255	.903	.720	.037	.025	.031	74.5	11.9	7.0	N_{pc} becoming T_m
Jan. 12													
0:01 a. m.	26	02	2.28	1.090	.777	.654	.025	.004	.014	80.3	25.7	8.4	P_p
Jan. 14													
3:02 a. m.	13	46	4.13	1.036	.773	.653	.047	.047	.047	60.0	8.4	4.2	N_{pc}
0:14 p. m.	26	02	2.28	1.324	.932	.766	.040	.052	.046	72.3	6.3	4.2	
3:02 p. m.	14	16	3.99	1.121	.825	.686	.040	.031	.036	62.1	6.2	3.1	

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during January 1936, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*—Continued

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY—Continued

Date and hour angle	Solar altitude		Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w-r}}{1.94}$	$\frac{I_{w-r}-I_m}{1.94}$	w	Air-mass type
										Percentage of solar constant			
Jan. 16													
0:28 a. m.	26	23	2.25	1.227	.874	.711	.059	.057	.058	69.1	7.9	5.3	P_P P_C, N_{PP} aloft
1:58 p. m.	24	50	2.37	1.311	.943	.766	.035	.014	.024	78.0	12.6	8.5	
Jan. 17													
3:04 a. m.	13	59	4.08	1.030	.761	.654	.049	.071	.060	63.8	12.3	6.2	P_C, P_P aloft
1:22 a. m.	26	43	2.22	1.293	.930	.752	.046	.029	.038	72.8	8.0	5.4	
1:36 p. m.	23	08	2.54	1.337	.942	.776	.032	.050	.041	71.5	4.5	3.0	
Jan. 20													
2:33 a. m.	18	14	3.18	1.040	.763	.646	.069	.072	.070	71.1	8.0	4.5	P_C
0:19 p. m.	27	22	2.16	1.399	.970	.788	.028	.029	.028	77.7	7.2	5.4	
2:59 p. m.	15	07	3.79	1.263	.909	.737	.016	.013	.014	72.2	9.2	4.8	
Jan. 21													
3:03 a. m.	14	48	3.86	.900	.704	.595	.080	.062	.071	54.4	9.1	4.7	P_C
1:15 a. m.	25	22	2.33	1.230	.886	.738	.060	.050	.055	70.0	8.6	5.7	
0:34 a. m.	27	29	2.16	1.250	.900	.740	.070	.074	.072	77.6	15.2	10.4	
Jan. 22													
0:56 a. m.	26	37	2.23	1.150	.813	.684	.083	.144	.114	59.7	2.3	1.4	N_{PC}
0:17 a. m.	27	50	2.14	1.240	.855	.729	.023	(?)	.023	79.3	17.4	9.1	
Jan. 24													
0:15 a. m.	28	19	2.10	0.984	.718	.610	.148	.152	.150	55.5	6.4	4.2	P_C, N_{PP} aloft
Jan. 25													
2:00 a. m.	22	43	2.58	1.197	.853	.709	.050	.057	.054	69.0	10.2	6.4	P_C, N_{PP} aloft
0:39 a. m.	27	59	2.12	1.330	.918	.765	.048	.081	.064	70.2	3.8	2.2	
0:15 p. m.	28	34	2.08	1.362	.992	.775	.042	(?)	.042	74.8	6.7	4.7	
2:35 p. m.	19	01	3.05	1.260	.900	.776	.050	.084	.067	60.5	3.8	2.2	
Jan. 26													
2:12 a. m.	21	44	2.69	1.218	.860	.725	.057	.065	.061	65.2	4.3	2.5	P_C, N_{PP} aloft
0:12 a.m.	28	50	2.07	1.361	.927	.764	.036	.069	.052	72.8	4.8	3.3	
3:12 p. m.	15	52	3.61	1.283	.853	.718	.001	.050	.026	69.0	4.9	2.6	
Jan. 28													
2:44 a. m.	18	35	3.11	1.059	.755	.656	.077	.125	.101	53.8	1.4	0.8	P_C
0:21 a. m.	29	24	2.02	1.476	.923	.746	(?)	.051	.051	74.0	0.2	0.14	
Jan. 29													
3:05 a. m.	16	09	3.57	1.074	.792	.688	.075	.091	.083	54.4	1.9	1.0	P_C, P_P aloft
1:03 a. m.	27	57	2.13	1.386	.960	.794	.038	.065	.052	72.5	3.2	2.1	
0:34 p. m.	29	10	2.05	1.446	.990	.812	.075	.049	.062	71.0	(?)	5.2	
1:56 p. m.	24	03	2.45	1.403	.997	.797	.020	.010	.015	78.4	8.2	5.3	
Jan. 30													
2:57 a. m.	17	00	3.39	1.118	.822	.695	.062	.095	.078	56.3	0.6	0.33	P_C, P_P aloft
0:18 p. m.	29	48	2.05	1.396	.963	.782	.030	.050	.040	75.3	6.5	4.6	
2:54 p. m.	17	47	3.24	1.173	.799	.673	.024	.072	.048	64.4	6.7	3.8	
Jan. 31													
2:01 a. m.	23	47	2.48	0.787	.575	.497	.165	.200	.182	45.7	6.2	4.0	N_{PC}
0:20 p. m.	24	01	2.45	0.805	.575	.497	.149	.200	.174	47.8	7.5	4.8	

Atmospheric conditions during solar radiation measurements, Harvard University Blue Hill Observatory

Date and time from apparent noon	Air temperature	Wind, Beaufort scale	Visibility (scale 0–10)	Sky blueness	Cloudiness and remarks
January 1936	°F.				
8; 2:31 a. m.	m. 1.4	NW 4	8	7	1 Ci. Light to mod. haze, N, NE.
12; 0:39 a. m.	p. 1.1	NW 2	7	7	Few Cu. Light to mod. water haze.
14; 2:49 a. m.	m. 5.0	NW 5	9	7	Few Ci. Light haze to NE.
16; 0:03 p. m.	p. 1.1	W 7	9	7	No clouds.
16; 1:43 p. m.	p. 2.5	W 7	9	7	Few Ci.
17; 1:09 a. m.	m. 3.6	NW 3	9	7	No clouds. Moderate haze to NE.
20; 1:42 p. m.	m. 7.8	NW 5	10	8	Few Ci. Light haze to NE.
21; 1:14 a. m.	m. 6.8	W 3	8	8	Few Ci. Moderate haze.
22; 0:44 a. m.	m. 0.6	SW 5	7	8	Do.
22; 0:16 p. m.	p. 0.2	SW 5	8	8	Few Ci., few Cu. Moderate haze.
23; 0:53 a. m.	m. 14.2	WSW 6	8	8	No clouds. Moderate haze.
24; 0:58 a. m.	m. 12.3	SW 7	8	7	Few Cu. Light to moderate haze.
25; 2:48 a. m.	m. 12.7	W 5	9	8	No clouds. Light haze.
25; 0:30 a. m.	m. 9.3	W 5	9	8	Do.
26; 0:24 p. m.	m. 8.3	W 3	8	8	1 Ci. Moderate haze to NE.
28; 1:09 a. m.	m. 9.2	NW 7	9	7	2 Ci. Light haze to N.
29; 1:17 a. m.	m. 10.3	WNW 5	9	8	Few Ci. Light haze.
30; 2:55 a. m.	m. 15.9	NW 3	9	7	Few Ci. Moderate haze.
30; 0:30 a. m.	m. 11.9	NNW 2	8	8	Do.
31; 0:26 a. m.	m. 9.8	WNW 3	8	6	No clouds. Moderate to dense haze.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy, (Ret.), Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time		Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1936	h	m	°	°	°				
Jan. 1	11	0	−76.0	298.2	+25.0		347		Mt. Wilson.
			−21.0	353.2	−12.0		635		
			−18.0	356.2	+18.0	64			
			+2.0	16.2	−4.0	5			
			+22.0	36.2	−23.0		201		
			+28.0	42.2	−29.0		61		
			+31.0	45.2	+13.0		21		
			+79.0	93.2	+14.0	42		1,376	
Jan. 2	12	40	−68.0	291.9	+27.0		349		Do.
			−8.0	351.9	−12.0		539		
			−2.0	357.9	+18.5	55			
			+36.0	35.9	−22.0	334			
			+49.0	48.9	+16.0		7		
			+56.0	55.9	−23.0		7	1,291	
Jan. 3	11	6	−57.0	290.8	+30.0		617		U. S. Naval.
			−49.0	298.8	+27.5	93			
			+4.0	351.8	−11.5		494		
			+11.0	358.8	+19.5	93			
			+49.5	37.3	−23.0	247		1,544	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1936	h	m	°	°	°				
Jan. 4	11	0	−41.0	293.6	+26.0		1,070		Mt. Wilson.
			+19.0	353.6	−12.0		770		
			+22.0	356.6	+17.0	65			
			+61.0	35.6	−24.0		168	2,073	
Jan. 5	11	10	−30.0	291.5	+28.0		943		Do.
			+32.0	353.5	−12.0		861		
			+36.0	357.5	+18.0	31			
			+74.0	35.5	−22.0	188		2,023	
Jan. 6	11	20	−18.0	290.2	+28.0		939		Do.
			+46.0	354.2	−11.0		641		
			+50.0	358.2	+18.0		14		
			+89.0	37.2	−22.0	191		1,785	
Jan. 7	11	26	−3.0	291.9	+29.0		710		U. S. Naval.
			+59.5	354.4	−11.5	463		1,173	
Jan. 8	12	20	+9.0	290.3	+31.0		813		Mt. Wilson.
			+74.0	355.3	−12.0	574		1,387	
Jan. 10	11	22	−68.0	187.4	−12.0	154			U. S. Naval.
			+36.0	291.4	+29.0		586	740	
Jan. 11	11	10	−80.0	162.4	−22.0	19			Mt. Wilson.
			−78.0	164.4	−29.0	186			
			−52.0	190.4	−14.0	75			
			+45.0	287.4	+31.0		209	489	
Jan. 12	12	0	−67.5	161.2	−17.0		219		Harvard.
			−64.0	164.7	−26.0		398		
			−38.0	190.7	−11.5	128			
			+64.5	293.2	+27.0		367	1,112	
Jan. 13	13	44	−56.0	158.6	−19.0		154		U. S. Naval.
			−52.0	162.6	−27.0	247			
			−25.0	189.6	−12.0	93			
			+71.0	285.6	+31.0	93		587	
Jan. 14	11	0	−75.0	128.0	−23.0	46			Do.
			−68.0	135.0	−30.0		278		
			−43.0	160.0	−19.5		185		
			−40.0	163.0	−28.0	278			
			−12.0	191.0	−13.0	63		850	
Jan. 15	11	38	−54.0	135.4	−29.5		564		Harvard.
			−26.0	163.4	−18.5	147			
			−26.0	163.4	−27.5	316			
			+1.0	190.4	−13.0	102		1,129	
Jan. 16	11	12	−52.0	124.5	−22.0		62		U. S. Naval.
			−54.0	122.5	−29.0		772		
			−15.0	161.5	−29.0	216			
			−14.5	162.0	−19.5	93			
			+13.0	189.5	−14.0	77		1,220	
Jan. 17	14	10	−39.0	122.7	−23.0		247		Do.
			−28.0	133.7	−31.0		926		
			−1.5	160.2	−29.0	231			
			−1.0	160.7	−20.0	116			
			+27.5	189.2	−14.0	62		1,582	
Jan. 18	12	45	−26.0	123.3	−24.0		387		Mt. Wilson.
			−14.0	135.3	−32.0		1,103		
			+12.0	161.3	−20.0	119			
			+12.0	161.3	−29.0	260			
			+40.0	189.3	−13.0	90		1,959	
Jan. 19	13	0	−80.0	56.0	−20.0		124		Do.
			−13.0	123.0	−24.0		363		
			−2.0	134.0	−32.0		1,193		
			+26.0	162.0	−21.0	127			
			+26.0	162.0	−29.0		242		
			+47.0	183.0	−22.0	5			
			+54.0	190.0	−14.0		67	2,121	
Jan. 20	11	2	−68.0	55.9	−18.0	31			U. S. Naval.
			−1.0	122.9	−23.0		216		
			+8.0	131.9	−32.0		1,019		
			+38.0	161.9	−29.0	185			
			+38.5	162.4	−20.5	123			
			+65.0	188.9	−14.0	15		1,589	
Jan. 21	11	11	−76.0	34.7	+16.5		216		Do.
			−53.0	57.7	−18.5		62		
			+12.0	122.7	−24.0		185		
			+21.0	131.7	−32.5		1,389		
			+49.0	159.7	−29.0	185			
			+50.0	160.7	−20.5	62		2,099	
Jan. 22	11	12	−69.0	28.5	+18.0		494		Do.
			−40.0	57.5	−18.0	62			
			+25.0	122.5	−24.0		93		
			+35.0	132.5	−33.0		1,389		
			+61.0	158.5	−29.0	154			
			+62.0	159.5	−20.0	62		2,254	
Jan. 23	11	53	−52.0	32.0	+18.0		1,005		Harvard.
			−24.5	59.5	−18.0	117			
			+3.0	87.0	−24.0	27			
			+40.5	124.5	−27.0	37			

POSITIONS AND AREA OF SUN SPOTS—Continued

Date	Eastern standard time		Heliographic			Area		Total area for each day	Observatory
			Diff. in longitude	Longitude	Latitude	Spot	Group		
1936	h	m	°	°	°				
			+49.0	133.0	−35.0		1,370		
			+77.0	161.0	−32.0	350			
			+80.0	164.0	−23.0	143		3,058	
Jan. 24	11	4	−78.0	353.3	−11.0	123			U. S. Naval.
			−40.0	31.3	+18.0		648		
			−12.0	59.3	−19.0	62			
			+15.0	86.3	−24.0		62		
			+52.0	123.3	−25.0	31			
			+60.0	131.3	−32.0		1,204	2,130	
Jan. 25	12	1	−61.5	356.1	−9.5	219			Harvard.
			−23.5	34.1	+17.5		546		
			−0.5	57.1	−18.5	66			
			+26.5	84.1	−26.5	47			
			+75.0	132.6	−36.0	1,288		2,166	
Jan. 26	15	0	−48.0	354.8	−11.0		199		Mt. Wilson.
			−40.0	2.8	+14.0		9		
			−8.0	34.8	+16.0		460		
			+16.0	58.8	−19.0		36		
			+24.0	66.8	−24.0		6		
			+40.0	82.8	−27.0		6		
			+63.0	105.8	−18.0	6			
			+80.0	122.8	−35.0		122	844	
Jan. 27	11	11	−37.5	354.2	−11.5		123		U. S. Naval.
			+4.0	35.7	+15.0		401		
			+27.5	59.2	−19.5	31		555	
Jan. 28	11	0	−25.0	353.6	−12.0		185		Do.
			+17.0	35.6	+15.0		432		
			+40.0	58.6	−19.0	31		648	
Jan. 29	11	1	−11.0	354.5	−12.0		123		Do.
			+29.0	34.5	+15.0		278		
			+53.0	58.5	−19.0	23		424	
Jan. 30	12	11	−65.0	286.6	+33.0		71		Harvard.
			+4.0	355.6	−11.5	128			
			+47.5	39.1	+13.0		155	354	
Jan. 31	11	1	−62.0	277.1	+31.5		185		U. S. Naval.
			+16.0	355.1	−12.0		123		
			+55.0	34.1	+15.0		216	524	

Mean daily area for 30 days, 1,370.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR JANUARY 1936

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

January 1936	Relative numbers	January 1936	Relative numbers	January 1936	Relative numbers
1	d 52	11	d 28	21	d 99
2	68	12	36	22	
3	b 55	13	d 45	23	104
4	69	14		24	d 107
5	63	15	Ec 61	25	85
6	50	16	56	26	72
7	a 37	17	a 58	27	74
8	37	18	79	28	50
9	41	19	b 76	29	
10	27	20	a 87	30	ad 37
				31	39

Mean, 28 days=60.4.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. T. SAMUELS

At those stations with a sufficient period of record for the determination of approximate normals, upper air temperatures during January averaged below normal except at Boston and San Diego where the departures were positive. (See table 1.) The largest departures from normal occurred at Omaha. The means at Seattle are based on only eight observations and are therefore not representative. It will be noted from table 1 that the temperature at 5 kilometers averaged considerably lower at Fargo than in the eastern and western sections of the country at the same latitude.

Upper-air relative humidity departures were negative at Washington and Pensacola notwithstanding the fact that temperatures at those stations were below normal. At Omaha, however, where the largest negative temperature departures occurred, the relative humidities averaged considerably above normal.

The direction of the upper-air wind resultants were remarkably close to normal over the entire country (table 2). Resultant velocities were generally above normal except over the northeast and extreme western part of the country where negative departures occurred. In a number of cases both the positive and negative departures exceeded 3.0 meters per second.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during January 1936*

TEMPERATURE (°C.)

Stations	Altitude (meters) m. s. l.																		Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.[1] (52 m)	3.6		6.6		7.6		7.0		4.7		2.6		0.2		-4.8		-11.0		28
Billings, Mont.[2] (1088 m)	-6.6						-3.5		-5.7		-8.4		-12.4		-18.5		-25.2		30
Boston, Mass.[1] (5 m)	-0.4	+1.3	-1.5	+1.9	-3.1	+1.7	-3.6	+1.9	-4.2	+2.6	-6.2	+2.5	-8.8	+2.1	-13.6	+2.5	-20.7	+1.3	16
Cheyenne, Wyo.[2] (1873 m)	-5.7								-5.2		-6.8		-9.2		-16.0		-23.6		30
El Paso, Tex.[2] (1194 m)	3.5						6.8		5.3		3.1		0.3		-4.8		-11.0		31
Fargo, N. Dak.[2] (274 m)	-22.1		-20.1		-17.2		-15.0		-14.7		-15.8		-18.0		-23.7		-30.7		30
Kelly Field (San Antonio), Tex.[1] (206 m)	3.6		8.2		10.1		9.6		7.9		5.5		2.6		-2.9		-10.2		25
Lakehurst, N. J.[3] (39 m)	-3.7		-4.3		-5.6		-6.2		-8.2		-9.7		-12.4		-19.1				21
Maxwell Field (Montgomery), Ala.[1] (52 m)	6.8		6.4		6.5		5.1		3.2		1.7		-0.6		-6.9		-13.6		22
Mitchel Field (Hempstead, L. I.), N. Y.[1] (29 m)	-3.7		-4.8		-6.2		-6.9		-9.0		-10.2		-12.6		-18.0		-23.2		23
Murfreesboro, Tenn.[2] (174 M)	-1.9		-1.2		-1.3		-1.2		-2.2		-4.2		-6.5		-10.8		-16.6		29
Norfolk, Va.[3] (10 m)	1.0	-4.0	1.0	-3.5	-0.5	-3.6	-1.3	-3.1	-2.0	-2.5	-3.8	-2.5	-6.1	-2.9	-10.6	-2.7	-17.2	-2.7	17
Oklahoma City, Okla.[2] (391 m)	-2.0		-1.4		1.5		1.1		0.1		-2.0		-4.9		-11.3		-17.2		26
Omaha, Nebr.[2] (300 m)	-13.9	-7.0	-12.5	-6.8	-8.6	-5.8	-6.6	-5.1	-7.4	-5.0	-9.6	-5.0	-12.1	-4.9	-18.0	-4.8	-24.2	-4.4	29
Pensacola, Fla.[3] (24 m)	8.9	-1.4	9.1	-1.3	8.3	-1.0	6.9	-1.1	5.2	-1.1	3.4	-0.9	1.4	-0.7	-4.0	-0.7	-10.8	-1.8	27
San Diego, Calif.[3] (10 m)	9.2	-2.2	13.1	+0.8	11.5	+0.7	9.7	+1.0	7.5	+1.1	5.4	+1.3	3.1	+1.4	-2.7	+1.8	-9.0	+2.0	31
Scott Field (Belleville), Ill.[1] (135 m)	-8.1		-6.2		-4.4		-4.5		-6.7		-9.0		-11.1		-16.8		-22.9		17
Seattle, Wash.[3] (25 m)	6.0	+0.1	3.8	-1.8	2.4	-1.9	1.1	-1.0	-1.3	-0.5	-4.0	-0.1	-6.4	+0.4	-12.7	+0.3	-20.2	+0.1	8
Spokane, Wash.[2] (596 m)	-0.9				0.1		-0.8		-2.9		-5.6		-8.7		-15.8		-22.6		29
Washington, D. C.[3] (13 m)	-2.7	-2.5	-3.6	-3.4	-4.6	-3.4	-5.2	-3.0	-6.6	-3.2	-8.5	-3.7	-10.2	-3.5	-14.7	-3.8	-19.5	-3.4	23
Wright Field (Dayton), Ohio[1] (244 m)	-5.8		-5.3		-6.2		-6.5		-7.5		-9.8		-12.1		-17.8		-25.7		21

RELATIVE HUMIDITY (PERCENT)

Stations	Surface Mean	Surface Departure	500 Mean	500 Departure	1,000 Mean	1,000 Departure	1,500 Mean	1,500 Departure	2,000 Mean	2,000 Departure	2,500 Mean	2,500 Departure	3,000 Mean	3,000 Departure	4,000 Mean	4,000 Departure	5,000 Mean	5,000 Departure	Number of observations
Barksdale Field (Shreveport), La.	78		60		46		39		39		34		33		29		27		
Billings, Mont.	60						53		54		58		64		67		70		
Boston, Mass.	74	+2	76	+5	74	+3	63	-3	53	-10	52	-8	54	-5	50	-7	50	-6	
Cheyenne, Wyo.	70								68		66		66		63		60		
El Paso, Tex.	51						44		41		40		40		37		31		
Fargo, N. Dak.	78		78		74		70		68		60		57		52		50		
Kelly Field (San Antonio), Tex.	78		59		48		38		32		27		25		22		20		
Lakehurst, N. J.	75		70		69		61		56		48		46		46				
Maxwell Field (Montgomery), Ala.	70		62		49		44		38		36		33		33		31		
Mitchel Field (Hempstead, L. I.), N. Y.	76		75		71		66		63		55		52		51		54		
Murfreesboro, Tenn.	83		79		75		68		57		53		50		45		46		
Norfolk, Va.	77	+4	69	+1	62	-1	53	-4	47	-4	41	-5	43	0	50	+5	58	+8	
Oklahoma City, Okla.	73		70		59		54		50		47		45		44		44		
Omaha, Nebr.	82	0	79	+1	73	+6	68	+9	66	+13	64	+12	63	+11	60	+11	58	+12	
Pensacola, Fla.	81	0	74	0	66	-2	58	-4	51	-5	47	-5	43	-5	38	-4	39	+2	
San Diego, Calif.	86	+14	65	+4	54	+1	43	-4	40	-2	39	+1	39	+4	38	+5	39	+7	
Scott Field (Belleville), Ill.	78		68		54		48		48		42		37		42		46		
Seattle, Wash.	79	-4	74	0	67	-2	57	-8	58	-7	57	-5	49	-8	47	-8	45	-10	
Spokane, Wash.	86				81		70		66		64		61		60		55		
Washington, D. C.	68	-2	56	-5	55	-2	47	-6	43	-6	41	-5	38	-4	42	-2	46	-2	
Wright Field (Dayton), Ohio	79		78		75		67		62		63		64		66		60		

Observations taken about 4 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at dawn.

[1] Army.
[2] Weather Bureau.
[3] Navy.

NOTE.—The departures are based on "normals" covering the following total number of observations made during the same month in previous years, including the current month: Boston, 73; Norfolk, 96; Omaha, 148; Pensacola, 155; San Diego, 182; Seattle, 30; Washington, 153.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during January 1936*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	6	0.7	292	2.2	266	3.6	281	3.4	275	5.3	272	1.5	254	1.5	252	2.3	328	2.0	356	0.8	104	2.1	152	0.7	297	0.9
500			286	4.2			288	7.9			290	2.4	248	6.1	270	4.2	340	3.9	251	2.4	128	5.1	139	1.1	277	3.2
1,000			282	9.1			290	8.2			267	6.9	260	10.0	281	7.4	310	3.2	258	4.5	156	4.0	191	2.2	278	6.2
1,500			285	10.9	267	10.2	283	8.8			267	8.1	265	12.6	266	8.2	305	5.5	270	6.5	198	2.7	202	3.9	286	9.7
2,000	304	3.9	286	11.4	282	11.1	277	8.1	278	7.9	281	11.8	262	10.7	264	8.7	298	7.4	270	10.0	222	3.6	269	4.3	286	12.8
2,500	300	7.9	281	13.2	285	11.8	266	7.7	292	14.1	284	14.8					300	8.9	265	11.4	240	3.5	311	5.8	287	13.5
3,000	301	11.2	271	13.2	286	12.9	259	6.0	301	14.1	295	12.6					288	8.5	268	15.4	251	3.9	322	8.8	289	11.9
4,000	296	16.5			301	16.2			308	11.4									274	16.9	256	8.1				
5,000	291	17.5																								

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii [1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	280	2.1	54	0.3	309	0.6	343	1.4	61	1.7	25	2.8	288	2.4	162	2.7	65	1.2	52	1.4	168	1.9	212	1.7	295	2.8
500	301	6.1	13	2.0	213	2.1	327	3.7	92	3.6	339	1.8	277	5.8			10	0.9	4	2.0	185	3.8			293	7.3
1,000	298	8.2	3	2.2	247	6.8	306	9.1	68	3.7	265	5.1	279	10.2			350	1.5	322	5.0	204	4.4	213	2.9	285	8.1
1,500	287	8.9	344	1.6	269	7.3	299	11.0	75	3.5	269	7.4	292	11.7	183	3.3	317	3.2	311	6.8	218	4.3	236	4.3	288	9.6
2,000	271	11.9	310	1.9	275	10.2	298	13.1	59	4.3	282	10.1	293	13.3	213	2.5	314	4.4	284	6.6	217	4.6	267	3.7	279	9.3
2,500	282	12.2	308	3.2	283	12.1	304	15.5	42	3.8	274	11.7	295	13.8	268	3.8	316	5.8	277	8.5	226	3.9	287	4.6	263	10.5
3,000			318	5.1	291	12.3	294	14.7	13	3.3	265	13.4	293	13.8	290	6.0	305	5.6	277	10.7			279	6.7		
4,000			253	1.1											310	9.8	297	9.2								
5,000			120	0.6													251	9.6								

[1] Navy stations.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES, in charge]

By W. J. MOXOM

In the southeastern part of the country there were two flood periods; the first was from the 3d to the 13th, and the second from the 19th to the 27th. Crest stages were only moderately high, except in the second overflow of the Roanoke River (Virginia and North Carolina) where they were the highest since March 1912.

Flood losses in the Southeastern States amounted to approximately $270,000. Considerable damage was done to farm lands by erosion, and many highway bridges over the small streams were undermined and weakened by high water.

Flood stages were also reached in the Little Kanawha River in West Virginia and in the Ohio River at Evansville, Ind., but the losses were comparatively small.

On the Pacific Slope drainage, moderate floods occurred in the Sacramento and Willamette Rivers, with losses of approximately $68,000 to immovable property.

Warnings of the overflows were issued well in advance and resulted in large savings in movable property and livestock.

Table of flood stages in January 1936

[All dates in January unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Delaware: Trenton, N. J.	12	3	3	16.1	3
James:					
Columbia, Va.	10	3	14	26.65	4
		16	16	10.0	16
		18	24	27.35	20
Richmond, Va.	8	3	6	15.7	5
		10	11	8.3	11
		19	22	15.9	21
		31	(1)		
Dan:					
Danville, Va.	11	4	4	12.3	4
		19	21	17.2	20
Clarksville, Va.	13	4	6	14.4	5
		20	22	17.0	22
Roanoke:					
Randolph, Va.	18	3	8	26.9	5
		10	11	20.7	10
		20	22	28.6	21

[1] Continued into February.

Table of flood stages in January 1936—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE—continued					
Roanoke—Continued.	*Feet*			*Feet*	
Weldon, N. C	31	4	13	43.7	7
		20	25	46.5	23
Williamston, N. C	10	7	Feb. 3	14.7	27
Neuse:					
Neuse, N. C	14	3	13	18.9	7
		20	24	18.9	22
Smithfield, N. C	13	4	14	19.2	9, 10
		20	25	18.0	21
Haw: Moncure, N. C	20	3	4	26.0	4
		7	7	22.0	7
		20	20	24.0	20
Cape Fear:					
Fayetteville, N. C	35	4	11	44.8	5
		20	22	41.3	21
Lock no. 2, Elizabethtown, N. C	20	4	14	31.3	7
		20	25	30.1	23
Peedee:					
Cheraw, S. C	27	4	5	32.8	5
		8	11	36.3	9
		20	23	39.2	21
Mars Bluff, Bridge, S. C	17	6	31	21.5	13
				23.0	25
Poston, S. C	18	11	31	21.3	16
				22.7	28
Saluda:					
Pelzer, S. C	6	3	12	11.5	4
		19	22	9.3	20
		26	26	6.0	26
Chappells. S. C	13	3	12	22.6	9
		19	23	22.4	20
Broad: Blairs, S. C	14	3	11	22.0	4
		19	21	24.0	19
Congaree: Columbia, S. C	19	5	5	19.7	5
		8	9	21.4	8
		20	21	23.1	20
Catawba:					
Catawba, N. C	10	19	20	20.1	19
Catawba, S. C	11	19	21	20.0	20
Wateree: Camden, S. C	23	8	10	27.1	9
		20	22	31.6	20
Santee:					
Rimini, S. C	12	5	31	21.0	24
Ferguson, S. C	12	6	31	14.8	26
Broad: Carlton, Ga	15	3	4	22.0	3
		7	7	16.0	7
		19	19	15.0	19
Savannah:					
CalhounFalls, S. C	8	3	4	8.4	3
Augusta, Ga	32	20	21	33.8	20
Ellenton, S. C	14	4	28	30.0	22
Ogeechee:					
Midville, Ga	6	23	25	8.0	23
Dover, Ga	7	19	21	7.0	19
		27	Feb. 2	9.5	28
Ocmulgee:					
Macon, Ga	18	5	5	19.1	5
		7	7	18.7	7
		19	21	22.0	20
Hawkinsville, Ga	25	23	24	25.6	23
Abbeville, Ga	11	11	31	14.0	14
				15.4	26
Lumber City, Ga	15	30	31	15.6	31
Oconee:					
Milledgeville, Ga	20	4	12	25.2	7
		19	22	31.6	20
Dublin, Ga	21	11	14	22.1	12, 13
		22	26	25.8	23
Altamaha:					
Charlotte, Ga	12	13	31	19.0	18, 19
				20.5	28, 29
Everett City, Ga	10	21	31	11.5	23–25
				12.0	31
EAST GULF OF MEXICO DRAINAGE					
Chattahoochee:					
West Point, Ga	19	3	3	19.4	3
Eufaula, Ala	40	20	21	47.8	20
Columbia, Ala	42	20	22	45.0	21
Alaga, Ala	32	6	7	34.6	7
		10	11	33.5	11
		20	23	39.9	21
Flint:					
Montezuma, Ga	20	22	22	20.8	22
Albany, Ga	20	21	22	21.7	21
		24	27	23.4	26
Bainbridge, Ga	25	24	24	25.0	24
Apalachicola:					
River Junction, Fla	20	22	25	23.4	23
Blountstown, Fla	15	5	(1)	22.5	24
Choctawhatchee:					
Newton, Ala	24	20	21	26.4	20
Geneva, Ala	23	5	5	23.0	5
		7	9	25.1	8
		21	24	27.5	22
Caryville, Fla	12	5	13	14.0	9
		20	27	14.1	23, 24

[1] Continued into February.

Table of flood stages in January 1936—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
EAST GULF OF MEXICO DRAINAGE—con.					
Conecuh:	*Feet*			*Feet*	
River Falls, Ala	35	20	23	37.7	20
Brewton, Ala	17	7	10	17.8	9
		21	25	18.3	23
Oostanaula:					
Resaca, Ga	22	20	23	27.4	21
Rome, Ga	25	9	10	26.6	10
		19	22	28.0	21
Etowah: Canton, Ga	17	19	20	20.6	19
Coosa:					
Mayos Bar Lock, Ga	28	9	10	30.4	10
		20	22	31.8	21
Gadsden, Ala	20	7	15	25.0	11
		20	27	23.5	21
Lock No. 4, Lincoln, Ala	17	8	14	20.1	10
		21	22	17.3	21, 22
Alabama:					
Montgomery, Ala	30	8	16	43.6	11
		20	24	36.3	21
Selma, Ala	35	9	18	46.9	12
		20	25	41.2	22
Millers Ferry, Ala	40	9	27	49.0	14, 15
Black Warrior: Lock no. 10, Tuscaloosa, Ala.	46	9	12	54.6	10
		19	22	52.4	20
Tombigbee:					
Lock No. 4, Demopolis, Ala	39	9	28	48.1	14
Lock No. 3	33	8	30	50.8	21
Lock No. 2	46	10	28	53.2	21
Lock No. 1	31	9	Feb. 1	37.2	21, 22
Pascagoula: Merrill, Miss	22	12	14	22.3	13
		21	21	22.1	21
Pearl:					
Jackson, Miss	18	19	25	19.3	22
Pearl River, La	12	6	7	12.2	7
		13	28	13.7	24
Ohio Basin					
Little Kanawha:					
Glenville, W. Va	23	3	3	24.2	3
Creston, W. Va	20	3	4	21.3	3
Cumberland: Celina, Tenn	28	7	11	29.9	9
North Fork of Holston: Mendota, Va	8	10	10	8.0	10
		19	20	10.0	19, 20
Holston: Rogersville, Tenn	13	20	20	13.5	20
Pigeon: Newport, Tenn	6	18	20	13.9	19
French Broad:					
Asheville, N. C	6	6	6	6.0	6
		19	21	8.3	19
Marshall, N. C	10	19	19	10.8	19
Hot Springs, N. C	14	19	19	14.5	19
Oldtown, Tenn	8	19	20	13.5	19
Dandridge, Tenn	12	19	20	18.8	19
Little Tennessee: McGhee, Tenn	18	19	20	20.9	20
Hiwassee: Charleston, Tenn	22	20	20	24.8	20
Elk: Fayetteville, Tenn	14	9	9	14.0	9
Tennessee:					
Knoxville, Tenn	20	20	21	23.1	20
Loudon, Tenn	22	20	21	22.4	21
Chattanooga, Tenn	30	10	11	30.7	10
		21	23	32.5	22
Bridgeport, Ala	18	10	13	22.0	11
		22	25	22.4	24
Widows Bar Lock, Ala.:					
Upper gage	17	9	13	22.9	11
		21	25	23.1	23
Lower gage	26	10	13	30.9	11
		21	24	31.2	23
Guntersville, Ala	25	9	14	29.7	12
		22	26	29.1	24
Florence, Ala	18	10	14	18.6	11–13
Riverton Lock, Ala	33	10	16	37.3	14
		25	27	34.0	26
Ohio:					
Evansville, Ind	35	12	14	35.2	13
Dam No. 47, Newburgh, Ind	38	-----	-----	37.6	13
Dam No. 50, Fords Ferry, Ky	34	13	16	34.7	15
PACIFIC SLOPE DRAINAGE					
Sacramento Basin					
Sacramento:					
Red Bluff, Calif	23	15	16	24.8	15
Knights Landing, Calif	30	17	18	30.1	17
Columbia Basin					
Coast Fork of Willamette: Saginaw, Oreg	9	4	4	11.4	4
		11	11	11.1	11
		13	13	11.2	13
Santiam: Jefferson, Oreg	10	4	5	14.0	5
		11	13	14.0	11, 12
South Yamhill: Willamina, Oreg	8	2	3	10.8	3
		12	13	12.9	12
Willamette:					
Eugene, Oreg	12	5	5	12.0	5
Harrisburg, Oreg	10	3	3	10.2	3
		5	6	13.3	5
		11	17	14.0	12, 13
Albany, Oreg	20	13	15	24.4	13
Salem, Oreg	20	13	15	23.8	14

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, WILLIS E. HURD, acting in charge]

NORTH ATLANTIC OCEAN, JANUARY 1936

By H. C. HUNTER

Atmospheric pressure.—Pressure averaged below normal over nearly all portions of the North Atlantic. Incomplete data from the Greenland-Iceland area, however, suggest that over most of that region pressure averaged above normal.

At Valencia, Ireland, the average pressure was 29.42 inches, or almost half an inch lower than normal; and only from the 11th to the 15th was the pressure higher than 30 inches. At Horta the average was 29.83 inches, one-third of an inch below normal; this monthly average departure is one of the largest of record for the station. The readings there were almost continuously less than 30 inches from the 7th to the 29th.

The highest reading, 30.58 inches, reported from a vessel was comparatively low to represent a winter month. It was made during the forenoon of the 1st on the American steamship *Delfina* when nearly 100 miles southeast of Cape May, N. J. The lowest mark was 28.30 inches (uncorrected), read on the British steamship *Blythmoor* on the forenoon of the 5th, the position being less than 200 miles south of the southern tip of Ireland. Table 1 indicates a reading of 28.30 inches at Lerwick, Shetland Islands, on the 10th. A corrected pressure of 28.39 inches was noted shortly before noon of the 28th by the Swedish motorship *Blankaholm* about 200 miles to westward of northwestern Scotland.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, January 1936*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.72	----------	30.13	19	29.10	26
Reykjavik, Iceland [1]	29.64	+0.18	30.02	6	29.01	28
Lerwick, Shetland Islands	29.38	-.32	30.07	14	28.30	10
Valencia, Ireland	29.42	-.48	30.21	12	28.88	6
Lisbon, Portugal	29.98	-.17	30.39	10	29.55	19
Madeira	30.02	-.08	30.32	31	29.61	18
Horta, Azores	29.83	-.33	30.21	5	29.42	18
Belle Isle, Newfoundland	29.63	-.17	30.34	10	28.58	21
Halifax, Nova Scotia	29.80	-.18	30.58	2	28.86	20
Nantucket	29.91	-.13	30.49	8	28.88	19
Hatteras	30.05	-.09	30.50	1	29.16	19
Bermuda	30.08	-.08	30.30	1, 2	29.64	31
Turks Island	30.04	-.01	30.14	7	29.92	23
Key West	30.04	-.06	30.24	31	29.82	19
New Orleans	30.06	-.07	30.54	28	29.55	18

[1] For 24 days.

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—As is to be expected in midwinter, there were many gales reported from the North Atlantic area. However, in only two instances was force 12 noted; and force 11 was reported as encountered only 10 times. Scarcely any of these especially intense gales were met anywhere near midocean.

Gales were experienced by numerous vessels in the waters near the coasts of Spain, France, and the British Isles during the first 6 days, especially on the 5th, when pressure was decidedly low over and to southwestward of Ireland. Also on the 5th and 6th several vessels encountered gales from the vicinity of Nova Scotia to the eastern limit of the Grand Banks and somewhat beyond, in connection with the eastward movement of a well-marked LOW. The situation on the 6th is shown by chart IX.

On the 5th the British steamship *Ulysses*, just out from Liverpool, bound for Brisbane, was swept by a huge wave in the Irish Sea, three men of the crew being killed and four injured. On this day the British steamship *Blythmoor* encountered winds of hurricane strength (force 12) when about 200 miles south of Ireland.

The LOW noted as near the Grand Banks on the 6th continued to move eastward, and about the 7th and 8th the development of a southward extension led to occurrence of noteworthy gales in latitudes about 35° to 42°, mainly from about midway between Bermuda and Horta to near the eastern limit of the Azores.

The Grand Banks LOW reached the vicinity of Ireland on the 9th, and many reports of intense gales over the waters to southward of that island have been received. The waters near the American coast from Delaware Bay to Newfoundland, and for considerable distances to eastward, were under the influence of two important storms from the 10th to 13th. Apparently it was the second of these which was the cause of damage to the rudder of the American liner *City of Hamburg*, partially crippling the vessel, which put into St. John's, Newfoundland, for repairs.

Another LOW, central on the morning of the 15th near Hatteras, traveled northeastward and this with the LOW preceding it may be found noted on chart X, for the 16th.

Numerous intense gales near the northeastern coast of the United States were reported on the 19th, in connection with a storm centered close to Hatteras. This storm, advancing rapidly northeastward, crossed the Gulf of St. Lawrence on the 20th. On the 23d an energetic LOW from the Lake region caused other gales over the same waters, as it traveled first southeastward, and then northeastward, to Labrador. This latter storm broke Nantucket lightship adrift, but the damage was not serious. From Labrador this storm moved across the ocean, to eastward at first, and thereafter more to northeastward, till it was not far to northwestward of Ireland on the 27th. This storm caused the first intense gales noted for over 2 weeks in the area east of midocean and north of the latitude of the Azores.

The second occurrence of force 12 during the month was on the 29th, not far to westward of the coast of Portugal, where the Belgian steamship *Makala* met the extreme wind while bound north for Antwerp. No other reports relating to this storm have been received from the area where the *Makala* met it.

In the southwestern part of the Caribbean Sea unusually strong trades (force 8) were noted on the 14th. There was a marked norther a few days later over the western part of the Gulf of Mexico, reported by one vessel near the Louisiana coast on the 18th. On the 19th a fishing boat outside Tampico harbor was capsized by unusually high waves and 11 of the crew lost their lives.

According to the United States consulate, Tenerife, Canary Islands, a severe storm of hurricane force prevailed at those islands for about 16 hours on the 21st. Damage to crops was considerable, that to the banana crop being estimated as 50 percent.

Fog.—Fog was less frequent than usual in January. In no part of the North Atlantic, save close to the coast of the United States, do reports at hand indicate its

occurrence on more than 3 days. Even some parts of the Grand Banks furnish only a single report of fog encountered.

The square from 35° to 40° N., 70° to 75° W., with 7 days, had more fog than any other area in the North Atlantic proper. Between the 70th and the 55th meridians, and south of the 35th parallel, Atlantic waters had very little fog this month.

Parts of the Gulf of Mexico had considerable fog, the square 25° to 30° N., 90° to 95° W., noting 11 days, 7 of which were among the first 12 days of January. Although this seems to be naturally the foggiest portion of the Gulf, yet the occurrences this year were abnormally many.

On the 17th, dense fog at the entrance to St. Johns River, below Jacksonville, Fla., led to a collision, by which the British steamship *Welcombe* was sunk; it was floated several days later, however. A less serious collision occurred in fog the following day in the Gulf of Mexico, near Sabine Pass. About the 28th the American steamship *Texas Banker* grounded near Aransas Pass, in foggy weather, but a fortnight later was floated and towed to port.

Coastal ice.—From Virginia northeastward, ice beyond that usually met in winter time was found in many coastal waters—bays, harbors, coastwise canals, and navigable rivers, especially during the last week of the month. Ice breakers and Coast Guard cutters were kept unusually busy.

OCEAN GALES AND STORMS, JANUARY 1936

Vessel	Voyage		Position at time of lowest barometer		Gale began January—	Time of lowest barometer January—	Gale ended January—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Perna, Du. M. S.	Rouen	Curacao	48 32 N.	6 00 W.	[1] 31	—, 1	3	28.86	SW	SW, 8	NW	W, 10	SW-W.
Trocas, Br. M. S.	Harburg	do	47 00 N.	9 50 W.	3	Noon, 3	3	29.34	WNW	WNW	WNW	WNW, 10	Steady.
Emilia, Am. S. S.	San Juan	New York	36 15 N.	72 50 W.	3	do	3	29.60	SSW	SSW, 9	NW	SSW, 9	SSW-NW-N.
Cranford, Am. S. S.	Hamburg	Tampa	44 45 N.	12 45 W.	4	5a, 5	6	29.10	SSE	S, 10	WSW	SE, 11	SE-S-WNW.
West Hika, Am. S. S.	Mobile	London	48 30 N.	12 08 W.	5	8a, 5	6	28.58	N	N, 10	WSW	WNW, 10	N-WNW.
Blythmoor, Br. S. S.	Shields	Cristobal	48 52 N.	9 22 W.	5	10a, 5	5	[2] 28.30	S	S, 8	W	W, 12	S-W-WNW.
Steel Inventor, Am. S. S.	Cristobal	London	48 36 N.	10 12 W.	5	do	5	28.55	SSE	Calm	W	SW, 11	SE-Calm-WSW.
Europa, Ger. S. S.	Cherbourg	New York	49 56 N.	11 40 W.	5	11a, 5	5	28.64	ESE	N, 10	WNW	NW, 10	E-N-NW.
Veendam, Du. S. S.	Rotterdam	do	50 17 N.	6 51 W.	5	5p, 5	6	28.60	S	S, 11	W	S, 11	S-SW.
Washington, Am. S. S.	Cobh	do	42 56 N.	57 37 W.	4	8p, 5	5	29.36	S	W, 9	W	W, 10	SSW-W.
Tennessee, Dan. S. S.	Newcastle	Boston	49 32 N.	47 53 W.	6	4p, 6	7	28.81	W	W	W	W, 11	
Europa, Ger. S. S.	Cherbourg	New York	47 31 N.	35 03 W.	6	10p, 6	7	28.93	WSW	WSW, 8	W	W, 10	SE-WSW-W.
Exermont, Am. S. S.	New York	Gibraltar	39 48 N.	32 50 W.	6	5a, 7	7	29.48	SW	WNW, 10	WNW	WNW, 10	WSW-WNW.
Boston City, Br. S. S.	Newport, England.	Philadelphia	45 40 N.	40 34 W.	6	3a, 8	10	28.77	S	W, 9	N	WNW, 10	W-NW.
Executive, Am. S. S.	Gibraltar	New York	36 30 N.	45 50 W.	6	6a, 8	10	29.50	SW	WSW, 10	NNE	WSW, 10	SW-WSW-NNE.
Bodegraven, Du. S. S.	Amsterdam	Curacao	36 49 N.	27 08 W.	8	Mdt., 8	9	29.39	SW	SW, 9	SW	SW, 9	None.
Blythmoor, Br. S. S.	Shields	Cristobal	44 55 N.	17 35 W.	9	6a, 9	9	[2] 29.03	SSE	S, 8	WSW	SSE, 11	SSE-WSW.
West Madaket, Am. S. S.	London	Mobile	47 27 N.	13 23 W.	9	9a, 9	9	28.98	S	SSW, 11	SW	SSW, 11	SSW-WSW.
General Gassouin, Fr. M. S.	New York	Antwerp	49 34 N.	13 45 W.	9	10a, 9	10	28.47	SSW	SW, 11	WSW	S, 11	S-SW-W.
Jean Jadot, Belg. S. S.	do	do	50 08 N.	9 32 W.	9	1p, 9	10	28.70	SSW	W, 10	W	W, 10	S-W.
Black Condor, Am. S. S.	Rotterdam	New York	43 30 N.	62 54 W.	10	8p, 10	10	29.32	SW	SW, 9	W	SW, 9	SE-W.
Black Tern, Am. S. S.	do	Boston	43 30 N.	60 40 W.	10	10p, 10	11	29.53	ESE	SE, 8	W	W, 10	ESE-S-W.
Executive, Am. S. S.	Gibraltar	New York	37 31 N.	61 30 W.	12	3p, 12	13	29.44	SW	WNW, 8	NW	NNE, 10	SW-WNW-NW.
Nako Maru, Jap. M. S.	Cristobal	do	10 54 N.	79 00 W.	14	7a, 14	15	29.72	NE	NE, 6	ENE	NE, 8	
Charles Pratt, Am. S. S.	Providence	Baytown, Tex.	36 00 N.	72 58 W.	15	10p, 15	16	29.38	SE	WSW, 10	WNW	WSW, 10	SE-WSW.
Elmsport, Am. S. S.	Liverpool	Galveston	36 20 N.	32 06 W.	17	3p, 17	17	29.36	NW	NW, 9	NNW	NW, 9	NW-NNW.
Solana, Am. S. S.	Fall River	Houston	34 45 N.	75 06 W.	19	2p, 19	20	29.26	S	SSW, 10	NW	SSW, 11	S-SSW-W.
Flora, Du. S. S.	Pto. Cabello	New York	38 54 N.	74 25 W.	19	3p, 19	19	29.05	W	W, 7	NW	W, 10	S-W-NW.
West Madaket, Am. S. S.	London	Mobile	32 20 N.	42 10 W.	19	4p, 19	20	29.82	NW	NW, 10	NNW	NW, 10	NW-NNW.
San Jacinto, Am. S. S.	New York	San Juan	35 50 N.	72 42 W.	19	6p, 19	20	29.28	SW	SW, 9	WNW	WNW, 10	SW-W.
Yankee Arrow, Am. S. S.	Portland	Beaumont	40 40 N.	69 00 W.	19	8p, 19	20	28.97	NE	SW, 10	WNW	SW, 11	SE-SW.
Palembang, Du. S. S.	Cape Verde Is.	Boston	42 24 N.	70 50 W.	19	9p, 19	20	28.93	NE	NE, 9	N	NE, 10	NE-N-WNW.
Champlain, Fr. S. S.	Southampton	New York	43 45 N.	55 30 W.	20	Noon, 20	21	[2] 29.17	SE	S	WNW	W, 10	SE-S-W.
Gulfking, Am. S. S.	Port Arthur	Beverly	36 20 N.	73 55 W.	23	2a, 23	25	29.54	WNW	WSW, 6	NW	NW, 10	WSW-WNW.
Thurland Castle, Br. M. S.	Penang	Halifax	39 01 N.	59 16 W.	24	6a, 25	26	29.75	W	WNW, 9	NW	WNW, 10	W-WNW-NW.
Maasdam, Du. S. S.	Rotterdam	New York	44 51 N.	43 05 W.	25	8p, 25	26	29.35	WSW	WSW, 8	W	W, 10	W-WSW-W.
Quaker City, Am. S. S.	Dundee	Boston	[3] 48 20 N.	46 43 W.	24	1a, 26	27	28.91	WSW	W	W	SW, 10	WSW-SW.
West Quechee, Am. S. S.	Lake Charles	Liverpool	49 57 N.	23 08 W.	26	11a, 26	28	28.84	SW	SW, 8	SW	W, 10	SSE-SW-WSW.
New York, Ger. S. S.	Cherbourg	New York	49 12 N.	37 12 W.	26	8p, 26	28	28.66	NW	WSW, 11	NW	WSW, 11	
Europa, Ger. S. S.	do	do	49 30 N.	22 00 W.	27	5a, 27	28	29.07	SW	WSW, 8	WSW	WSW, 10	SW-W-SW.
Brandywine, Am. S. S.	Boston	New Orleans	39 12 N.	71 18 W.	27	Noon, 27	28	30.02	NW	NW, 7	NW	NW, 10	
H. M. Flagler, Am. S. S.	Caripito	Boston	34 26 N.	67 24 W.	28	Noon, 28	29	29.72	W	NW, 9	NW	NW, 9	None.
Fernwood, Nor. M. S.	Sandefjord	Tampa	34 40 N.	50 05 W.	28	4p, 28	29	29.68	S	SSW, 10	WNW	SSW, 10	SSW-WSW.
Makala, Belg. S. S.	Congo River	Antwerp	37 50 N.	11 18 W.	28	5a, 29	30	29.74	SW	WSW, 12	WNW	WSW, 12	WSW-NW.
Europa, Ger. S. S.	Cherbourg	New York	43 54 N.	48 12 W.	28	2p, 29	30	28.94	S	SW, 8	WNW	W, 10	S-NW-W.
Excalibur, Am. S. S.	Malaga	Boston	42 24 N.	32 36 W.	29	8a, 30	31	29.44	SW	SW, 7	W	W, 10	SW-W.
Duivendrecht, Du. M. S.	Rotterdam	Philadelphia	46 32 N.	39 15 W.	30	Noon, 30	31	29.04	SW	WSW, 8	WNW	WSW, 10	SW-WSW.
Swiftsure, Am. S. S.	Tiverton	Norco	[3] 32 33 N.	72 07 W.	30	4p, 30	30	29.49	SSW	WSW	WNW	SSW, 9	SSW-WSW.
NORTH PACIFIC OCEAN													
Tai Ping, Nor. M. S.	Los Angeles	Kobe	30 13 N.	168 50 W.	1	2p, 1	1	29.03	N	E, 4	N	N, 11	E-N.
Stanley Hiller, Am. S. S.	Long View	Los Angeles	44 42 N.	124 16 W.	1	do	2	[2] 29.54	S	S, 5	SW	SW, 9	S-SW.
Mexican, Am. S. S.	Seattle	San Francisco	43 44 N.	124 41 W.	1	8p, 1	2	[2] 29.91	S	S, 8	S	S, 10	
Melville Dollar, Am. S. S.	Manila	do	37 42 N.	148 06 W.	2	1p, 2	3	29.48	S	S, 9	W	SW, 10	S-SW.
Golden Dragon, Am. S. S.	San Francisco	Yokohama	45 25 N.	142 15 W.	2	7a, 3	3	28.76	S	SSW, 10	WNW	SSW, 11	S-SSW-W.
Golden Tide, Am. S. S.	Dairen	San Francisco	46 28 N.	170 45 W.	3	2p, 3	3	28.92	NE	N, 9	NNW	N, 9	NE-N.
Kentucky, Am. S. S.	Cebu, P. I.	do	41 30 N.	138 38 W.	3	2a, 3	4	29.78	S	S, 7	W	W, 9	None.
Niagara, Br. S. S.	Victoria, B. C.	Honolulu	43 18 N.	134 55 W.	3	3p, 3	4	29.47	SW	SW, 12	WNW	SW, 12	None.
Maia, Am. S. S.	Bellingham	do	43 42 N.	131 10 W.	3	7p, 3	4	29.39	SW	SW, 8	WNW	W, 10	SW-WSW.
Hakutatsu Maru, Jap. S. S.	Yokohama	Grays Harbor	49 18 N.	138 00 W.	3	3a, 4	4	29.05	SE	W, 4	NW	NW, 10	
President McKinley, Am. S. S.	do	Victoria, B. C.	49 56 N.	164 48 W.	4	4a, 4	5	28.81	W	NW, 3	WSW	WSW, 8	SW-NW-W.
Silveray, Br. M. S.	Cebu, P. I.	Los Angeles	37 00 N.	165 52 W.		1a, 5		29.73		S, 9		S, 9	

[1] December. [2] Barometer uncorrected. [3] Position approximate.

OCEAN GALES AND STORMS, JANUARY 1936—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began January—	Time of lowest barometer January—	Gale ended January—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH PACIFIC OCEAN—Continued			° ′	° ′				*Inches*					
Rakuyo Maru, Jap. S. S.	Yokohama	Honolulu	33 00 N.	179 30 E.	4	2a, 5	4	29.37	SW	SW, 5	SW	SW, 8	SW-WSW.
Golden Tide, Am. S. S.	Dairen	San Francisco	46 23 N.	162 45 W.	4	4a, 5	5	28.95	SE	SSE, 8	WSW	SW, 9	SSE-SSW.
Saparoea, Du. M. S.	Manila	Portland, Oreg.	46 00 N.	179 24 E.	5	3a, 6	6	28.52	E	ENE, 8	N	E, 9	None.
Golden Dragon, Am. S. S.	San Francisco	Yokohama	48 06 N.	164 24 W.	8	4a, 9	9	28.75	WSW	W, 8	NW	WNW, 9	WSW-WNW.
General Lee, Am. S. S.	Yokohama	San Francisco	41 36 N.	134 00 W.	11	2p, 11	12	29.52	SSW	SSW, 9	SW	SSW, 10	None.
Golden Tide, Am. S. S.	Dairen	do	39 31 N.	126 25 W.	12	Noon, 12	12	29.83	SSW	S, 9	SSW	S, 10	None.
Grays Harbor, Am. S. S.	Taku Bar	Vancouver, B. C.	43 00 N.	155 40 E.	13	8p, 13	14	28.74	ESE	WNW, 9	WSW	W, 11	ESE-WNW-W.
Michigan, Am. S. S.	Manila	San Francisco	37 00 N.	149 00 E.	13	1p, 14	16	29.62	WNW	W, 10	NW	W, 10	None.
Columbia Maru, Jap. M. S.	San Francisco	Seikoshin	42 30 N.	145 12 E.	13	10p, 13	18	29.13	WSW	W, 8	NNW	W, 12	
Ogura Maru, Jap. M. S.	Ventura	Yokohama	31 29 N.	177 47 E.	15	Noon, 15	15	29.47	SSE	W, 8	WNW	SSE, 10	SSE-W.
President Grant, Am. S. S.	Yokohama	Victoria, B. C.	48 12 N.	173 36 E.	16	Noon, 16	17	29.36	S	S, 8		S, 9	
Golden Star, Am. S. S.	Manila	San Francisco	35 23 N.	143 45 E.	16	2p, 17	17	29.49	W	W, 8	WSW	W, 9	None.
City of Vancouver, Br. S. S.	Tsingtao	Los Angeles	43 08 N.	140 33 W.	16	8a, 17	17	29.62	S	S, 7	SW	S, 8	S-SSW.
Nichiyo Maru, Jap. M. S.	Yokohama	do	45 59 N.	176 55 E.	17	Mdt, 17	17	29.00	ENE	E, 8	E	E, 9	None.
Grays Harbor, Am. S. S.	Taku Bar	Vancouver, B. C.	48 40 N.	173 45 E.	17	4a, 18	18	29.14	E	ENE, 8	NE	NE, 9	None.
Michigan, Am. S. S.	Manila	San Francisco	40 00 N.	169 30 E.	19	Mdt, 18	19	29.03	WNW	WNW, 6	W	NW, 9	WSW-WNW.
President Grant, Am. S. S.	Yokohama	Victoria, B. C.	50 00 N.	163 36 W.	19	1a, 18	20	28.92	S	ESE, 6	S	S, 9	None.
Texan, Am. S. S.	Balboa	Los Angeles	15 33 N.	95 10 W.	22	7p, 22	22	29.72	NW	NNE, 11	E	NNE, 11	N-E.
Grays Harbor, Am. S. S.	Taku Bar	Vancouver, B. C.	50 05 N.	150 40 W.	24	Noon, 24	24	28.78	E	S, 9	S	S, 9	SE-S.
President Cleveland, Am. S. S.	Yokohama	Honolulu	34 25 N.	152 46 E.	24	do	25	29.81	NW	WNW, 8	WNW	WNW, 8	NW-WNW.
Michigan, Am. S. S.	Manila	San Francisco	44 — N.	149 — W.	24	4a, 25	25	29.18	W	SSE, 7	SSE	SSE, 9	SSE-S.
Anna Maersk, Dan. M. S.	Yokohama	Los Angeles	42 00 N.	163 30 W.	24	10a, 25	26	28.97	S	W, 10	SSE	W, 10	
President Jefferson, Am. S. S.	do	Victoria, B. C.	44 48 N.	161 30 E.	26	11p, 28	28	28.79	WNW	W, 6	WNW	W, 11	None.
Heian Maru, Jap. M. S.	do	Vancouver, B. C.	47 42 N.	173 06 E.	28	5p, 28	28	28.68	E	E, 8	SE	E, 8	E-S.

NORTH PACIFIC OCEAN, JANUARY 1936

By Willis E. Hurd

Atmospheric pressure.—As during the preceding December atmospheric pressure remained abnormally low over much, if not most, of the North Pacific Ocean. So far as can be judged from the data in table 1, negative departures were prevalent except within the region lying east of China and south of the principal Japanese Islands, where small plus departures are indicated for the area covered by the oceanic projection of the Asiatic anticyclone. The center of the Aleutian cyclone this month is best indicated by the low average pressure, 29.34 inches, occurring at Dutch Harbor. The departure from normal pressure at this station was −0.24 inch.

Anticyclonic activity was for the most part sporadic, and average pressures of 30 inches or higher occurred only off the coasts of China and California.

Table 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, January 1936, at selected stations*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	30.09	+0.01	30.70	31	29.48	21
Dutch Harbor	29.34	−.24	30.06	31	28.34	20
St. Paul	29.49	−.14	30.12	15	28.26	21
Kodiak	29.45	−.14	30.44	31	28.80	20
Juneau	29.85	−.03	30.46	30	29.08	7
Tatoosh Island	29.89	−.09	30.44	28	29.00	4
San Francisco	30.09	−.02	30.35	1	29.68	31
Mazatlan	29.90	−.05	30.02	15	29.84	5, 6, 17, 31
Honolulu	29.95	−.05	30.08	10	29.56	31
Midway Island	29.92	−.11	30.20	9	29.58	14
Guam	29.88	−.02	29.94	23, 31	29.76	1
Manila	29.88	−.01	29.96	29, 30	29.72	1
Hong Kong	30.06		30.25	17, 18	29.95	1
Naha	30.12	+.04	30.30	20	29.88	1
Chichishima	30.03	+.02	30.20	23	29.68	2
Nemuro	29.66		30.28	24	28.74	31

Note.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—The weather continued stormy during January over much of the North Pacific Ocean north of the thirtieth parallel. The greater part of this enormous area was mostly dominated by fluctuating cyclonic storms of the Aleutian type, many of which carried their influence southward well into middle latitudes. An unusual number of cyclones of Asiatic origin crossed northern Japan and entered the ocean this month. This is well indicated by the low average pressure, 29.66, recorded for Nemuro, near the northeastern extremity of Hokushu Island.

Although gales of record occurred over some part of the ocean on at least 26 days of the month, there were certain definite regions where frequency or energy of storminess was most pronounced. One region lay east of Japan, another within 6° or 8° north and east of Midway Island, and a third to the westward of the Washington and Oregon coasts.

Within the first region, lying roughly between 30° and 45° N., to the westward of 160° E., gales were reported on 10 days, the stormiest of which were the 12th to 17th. On the 13th and 14th a deep and intense cyclone lay over this section. The American steamer *Grays Harbor*, near 43° N., 156° E., reported a barometer of 28.74, accompanied by a west wind of force 11, on the 13th. On the following day, near the south coast of Hokushu, the Japanese motorship *Columbia Maru* reported a west wind of hurricane force, accompanied by rising pressure. During the 27th and 28th strong cyclonic conditions prevailed in the neighborhood, with the American steamer *President Jefferson*, near 45° N., 162° E., reporting the highest wind, W. 11, and the lowest pressure, 28.79 inches.

In the Midway Island area—30° to 36° N., 178° E. to 170° W.—pressures fell nearly to 29 inches, which was unusually low for the latitude, near the first and middle of the month; and gales of force 10 to 11 were experienced by ships on the 1st and 15th. On the 25th, near 34° N.,

178° W., winds as high as force 11 were again encountered. The neighborhood was stormy on several other dates, but no winds exceeding force 9 were reported.

Exceptionally heavy weather occurred off the Oregon and Washington coasts, and thence for several hundred miles seaward, during several days of January from the 1st to the 12th. On the 1st, south to southwest gales of force 9-10 were reported by the steamships *Mexican* and *Stanley Hiller* close in along the coast between 43° and 45° N. The maximum wind velocity at the North Head Weather Bureau Station on that date was 56 miles from the south. On the 3d and 4th the highest velocities reported at North Head were 57 and 56 miles, respectively, and during these days a long stretch of coast line was battered by high winds and seas which caused heavy damage to communication systems and other property. At sea, strong gales to hurricane velocities were experienced within the locality 43°-46° N., 130°-145° W., on the 3d, while on the 4th scattered westerly gales within much the same area were encountered of force up to 10.

Low pressure persisted over the northeastern part of the ocean between the 4th and 11th, but the weather meanwhile appears to have been only moderately stormy, with no gales at sea reported in excess of force 8, and those far from the coast. On the 12th, however, storminess increased locally along the Oregon coast and in the neighboring portions of the sea. The wind became violent during the night of the 11-12th near the mouth of the Columbia River, and the American steamer *Iowa*, caught in the early morning in a heavy gale, was wrecked on Peacock Spit, the so-called graveyard of ships, about 3 miles southwest of North Head Station, where she was lost with her entire crew of 34 men. This is reported as having been the first major marine disaster at that point since 1913. At North Head the maximum wind velocity registered that day was 73 miles from the south. At sea southerly gales of force 10 were reported on the 12th by the American steamers *General Lee* and *Golden Tide*, the first at 7 a. m., in 41°36′ N., 134° W., the second at 11 a. m., in 39°31′ N., 126°25′ W.

Along the middle stretches of the northern steamship routes gales were moderately frequent during the month, but so far as reported, despite the prevailing low pressures accompanying them, did not exceed 9 in force.

Tropical cyclones.—The subjoined report by the Reverend Bernard F. Doucette, S. J., of the Manila Observatory, indicates that two tropical disturbances, one of minor nature, occurred in the Far East during January 1936.

Tehuantepecers.—Ships traversing the Gulf of Tehuantepec reported northers of force 7 on the 7th and 20th, and of force 11, on the 22d.

Fog.—Fog was reported on 4 days off the Washington and Oregon coasts; on 10 days off the California coast, and on 2 days off the coast of Lower California. Farther at sea the occurrence of fog was rare and scattered.

TYPHOON AND DEPRESSION OVER THE FAR EAST, JANUARY 1936

By BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Two disturbances, one a typhoon, the other a depression, appeared during the first few days of the month. The depression affected the weather of the Philippines; the typhoon, however, remained at a distance in the Pacific Ocean.

Typhoon, December 31, 1935, to January 3, 1936.—A typhoon formed over the Eastern Caroline Islands, intensifying on the last day of the year near latitude 8.20° N., longitude 150° E. It moved WNW. about 1,150 miles and filled up January 3, 1936, in the regions around latitude 14° N., longitude 136° E.

Depression, December 29, 1935, to January 3, 1936.—Forming about 120 miles S. of Yap, this mild depression moved WNW. toward the Philippines. It passed over Surigao Strait, then across Leyte, Cebu, and Panay Islands on its way to Mindoro Island, where it recurved to the NE. It passed over the Camarines Provinces on its way to the Pacific Ocean, where it filled up, about 120 miles away from the coast. This depression was of little importance with respect to resulting damage, though considerable rain fell over the Visayan Islands and shipping was delayed slightly.

CLIMATOLOGICAL TABLES

DESCRIPTION OF TABLES AND CHARTS

(R. J. Martin)

Table 1 gives the data ordinarily needed for climatological studies for about 180 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m. daily, seventy-fifth meridian time, and for about 20 others making only one observation. The altitudes of the instruments above ground are also given.

Beginning with January 1, 1932, all wind movements and velocities published herein are corrected to true values by applying to the anemometer readings corrections determined by actual tests in wind tunnels and elsewhere.

Table 2 gives, for about 37 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sea-level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January 1902, **30:** 13-16.

Table 3 lists the severe local storms reported in the United States during the month. It is compiled from reports furnished mostly by officials of the Weather Bureau.

CHART I.—*Temperature departures.*—This chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly surface temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July 1909, but smaller charts appear in W. B. Bulletin U for 1873 to June 1909, inclusive.

CHART II.—*Tracks of centers of* ANTICYCLONES; and

CHART III.—*Tracks of centers of* CYCLONES. The roman numerals show the chronological order of the centers. The figures within the circles show the days of the month, the location indicated being that at 8 a. m., seventy-fifth meridian time. Within each circle is also an entry of the last three figures of the highest barometric reading (chart II), or (chart III) the lowest reading reported at or near the center at that time, in both cases as reduced to sea level and standard gravity. The intermediate 8 p. m. locations are indicated by dots. The inset map on chart II shows the departure of monthly mean pressure from normal and the inset on chart III

shows the change in mean pressure from the preceding month.

The use of a new base map for charts II and III began with the January 1930 issue.

CHART IV.—*Percentage of clear sky between sunrise and sunset.*—The average cloudiness at each regular Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the night hours.

CHART V.—*Total precipitation.*—The scales of shading with appropriate lines show the distribution of the monthly precipitation according to reports from both regular and cooperative observers. The inset on this chart shows the departure of the monthly totals from the corresponding normals, as indicated by the reports from the regular stations.

CHART VI.—*Isobars at sea level, and isotherms at surface; prevailing winds.*—The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow in the REVIEW for January 1902, **30:** 13–16. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observation, at stations taking but a single observation.

The diurnal corrections so applied, except for stations established since 1901, will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, table 27, pages 140–164.

The sea-level temperatures are now omitted and average surface temperatures substituted. The isotherms cannot be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at almost all the stations. A few stations determine their prevailing directions from the daily or twice-daily observations only.

CHART VII.—*Wind roses for selected stations.*—The publication of this chart began in the REVIEW for January 1935, and gives wind roses for 28 selected stations. The roses are based on hourly percentages for the month.

CHART VIII.—*Total snowfall.*—This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines connecting places of equal snowfall, but in special cases figures also are given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset on this chart, when included, shows the depth of snow on the ground at 8 p. m. of the Monday nearest the end of the month and is a copy of the snow chart appearing in the snow and ice bulletin for that week.

CHARTS IX, X, etc.—*North Atlantic weather maps for particular days.*

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, January 1936

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	45.7	−0.7	Pushmataha	80	17	Valley Head	−11	31	12.34	+7.50	Brantley	12.34	Riverton	3.03
Arizona	43.7	−.5	Goulds Ranch	80	11	Fort Valley	−4	2	.78	−.34	Oracle	2.60	2 stations	T
Arkansas	37.1	−4.2	Magnolia	83	16	4 stations	−1	[1] 24	1.05	−3.17	Crossett	4.59	Fayetteville	.13
California	46.6	+1.8	Indio	85	23	Twin Lakes	−6	[1] 12	5.00	+.17	Cummings	27.41	6 stations	.00
Colorado	25.0	+.9	Longmont	74	11	Fraser	−33	30	.76	.0	Steamboat Springs	4.48	3 stations	T
Florida	58.9	−.1	Brooksville	88	6	2 stations	20	[1] 28	5.11	+2.31	Garniers	18.65	West Palm Beach	1.64
Georgia	44.0	−2.9	Fargo	82	18	Dalton	−6	31	9.21	+4.94	Flat Top	17.32	Fargo	3.15
Idaho	24.1	−.1	Kooskia	56	15	Tetonia	−35	26	3.76	+1.55	Roland	12.08	Howe	.55
Illinois	20.7	−5.8	4 stations	66	12	Freeport	−27	23	1.40	−.88	Mount Carmel	2.09	Chester	.56
Indiana	22.4	−6.6	2 stations	65	12	Marengo	−27	28	1.47	−1.56	Scottsburg	2.86	Goshen	.75
Iowa	9.5	−9.0	Keokuk	56	12	Elkader	−33	24	1.68	+.60	Tingley	3.85	Inwood (near)	.45
Kansas	26.3	−3.5	2 stations	70	11	Horton	−21	27	.71	+.05	Leavenworth	1.99	Norton	.10
Kentucky	29.4	−7.9	Murray	68	12	Taylorsville	−25	28	2.99	−1.34	Jackson	5.69	Owensboro	.95
Louisiana	49.6	−2.0	Urania	85	16	2 stations	12	[1] 28	5.17	+.33	Paradis	11.54	Plain Dealing	1.23
Maryland-Delaware	28.1	−5.9	Snow Hill, Md	62	13	Oakland, Md	−20	25	6.00	+2.70	Dover, Del	7.95	Chewsville, Md	3.89
Michigan	18.1	−2.9	2 stations	48	[1] 12	2 stations	−26	[1] 19	1.85	+.01	Deer Park	4.52	Yale	.45
Minnesota	−1.4	−10.8	do	40	[1] 2	Warroad	−55	23	.76	+.01	Fairmont	1.62	Alexandria	.07
Mississippi	44.1	−3.2	Columbia	82	6	Tupelo	−10	31	6.20	+1.16	Gulfport	13.35	Yazoo City	2.25
Missouri	24.4	−6.4	Garber	74	12	Conception	−25	27	1.01	−1.30	King City	3.61	2 stations	.05
Montana	17.2	−2.5	Norris (near)	60	4	Glasgow	−43	19	1.02	+.14	Haugan	7.02	Ennis	.09

[1] Other dates also.

Condensed climatological summary of temperature and precipitation by sections, January 1936—Continued

Section	Temperature: Section average	Temperature: Departure from the normal	Monthly extremes: Station	Highest	Date	Station	Lowest	Date	Precipitation: Section average	Departure from the normal	Greatest monthly: Station	Amount	Least monthly: Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Nebraska	17.8	−5.5	Benkelman	70	11	Weeping Water	−34	26	.92	+.41	Auburn	3.39	Sappa Valley	.08
Nevada	33.7	+4.1	Logandale	73	11	Owyhee	−19	30	1.41	+.22	Marlette Lake	9.26	4 stations	.00
New England	21.3	−1.3	Waterbury, Conn.	56	3	Bloomfield, Vt.	−29	[1] 21	6.31	+2.81	Portland, Me.	10.01	Bethlehem, N. H.	2.77
New Jersey	27.2	−3.7	Burlington	59	13	Layton	−15	26	6.34	+2.77	Elizabeth	8.58	Northfield	3.09
New Mexico	32.1	−1.6	Carlsbad	77	11	Elizabethtown	−33	30	.86	+.30	Cloudcroft	4.02	Bloomfield	.05
New York	20.8	−2.3	Setauket	54	[1] 3	Stillwater reservoir	−27	26	3.55	+.62	Mount Vernon	7.73	Haskinville	.85
North Carolina	37.0	−4.5	4 stations	75	[1] 18	Mount Mitchell	−12	31	7.79	+4.06	Rock House	13.07	Kinston	1.95
North Dakota	−5.8	−12.4	Hettinger	43	13	Edmore	−44	24	.56	+.11	Howard	2.20	Mayville	.09
Ohio	22.7	−5.7	Peebles (near)	62	14	McArthur	−30	24	1.65	−1.35	Demos	3.50	Danbury	.68
Oklahoma	35.6	−2.7	Okemah	78	12	Hooker	−6	8	.39	−1.02	Hugo	1.17	Watts	T
Oregon	33.9	+2.0	Powers	72	29	Seneca	−32	30	6.79	+2.92	Haskins Dam	23.44	Mitchell	.91
Pennsylvania	23.6	−4.7	Greensburg	59	14	Ebensburg	−30	23	4.21	+.99	George School	7.74	Sharon	1.34
South Carolina	41.2	−4.6	Kingstree	80	18	Long Creek	−4	31	7.68	+4.08	Caesars Head	14.28	Florence No. 1	2.05
South Dakota	5.8	−10.2	Pine Ridge	58	11	Pollock	−39	31	.65	+.11	Wagner	1.41	Oelrichs	.02
Tennessee	34.3	−4.8	Madisonville	78	17	Rugby	−12	[1] 24	5.02	+.30	Parkersville	12.38	Newbern	.90
Texas	45.8	−2.4	Laredo	98	17	2 stations	−2	30	.75	−.94	Port Arthur	4.63	3 stations	.00
Utah	27.0	+1.7	2 stations	68	[1] 11	Woodruff	−26	7	1.57	+.37	Silver Lake	9.27	2 stations	.00
Virginia	31.0	−5.4	Holland	72	19	Big Meadows	−17	23	6.44	+3.20	Pinnacles	9.61	Timberville	2.72
Washington	34.2	+3.7	South Bend (near)	60	22	Bumping Lake	−18	28	7.20	+1.88	Cougar (near)	27.48	2 stations	.86
West Virginia	26.7	−5.8	2 stations	64	14	Reedsville	−31	25	4.01	+.38	Pickens	7.85	Dam No. 25, Ohio River.	1.84
Wisconsin	9.1	−6.0	Brodhead	46	14	Grantsburg	−42	[1] 23	1.31	+.11	Racine	2.90	Hatfield	.52
Wyoming	18.5	−1.7	Wheatland	67	11	Buffalo Ranch	−43	29	1.22	+.43	Bechler River	9.83	Archer	.06
Alaska (December)	1.2	−2.3	2 stations	58	[1] 18	Fort Yukon	−71	7	2.97	+.09	View Cove	32.53	Barrow	.00
Hawaii	70.6	+2.3	do	89	[1] 5	Kanalohuluhulu	33	29	6.03	−2.99	Hilea-Manawaiopuna Divide.	18.50	Ka Lae	.03
Puerto Rico	73.3	+.3	Manati	92	31	Guineo Reservoir	43	7	1.47	−2.11	Rio Blanco	6.34	Cabo Rojo No. 2	.00

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, January 1936*

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F		° F	° F.		° F	° F.	° F.	° F.	%	In.	In.		Miles								0-10	In.	In.
New England							24.6	+0.1										75	5.85	+2.4										5.9		
Eastport	76	67	85	29.76	29.84	−0.16	22.1	+1.7	49	3	30	−6	24	14	38	20	17	79	3.24	−0.7	12	10,896	nw.	45	ne.	19	9	3	19	6.7	8.2	3.8
Greenville, Maine	1,070	6	40	28.66	29.88	------	12.2	------	38	16	20	−20	31	4	40	----	----	----	8.04	------	13	6,600	n.	39	------	28	7	8	16	----	51.2	----
Portland, Maine	103	82	117	29.76	29.89	−.16	24.6	+2.2	48	3	32	−1	30	17	29	21	13	65	10.01	+6.0	16	7,423	n.	35	s.	3	17	6	8	4.3	29.8	.2
Concord	289	60	----	------	------	------	21.6	.0	45	4	30	−12	30	13	32	----	----	----	5.67	+2.7	15	------	nw.	----	------	---	10	11	10	----	25.1	----
Burlington	403	11	48	29.49	29.96	−.09	15.2	−3.6	40	3	23	−15	30	7	38	----	----	----	3.46	+1.7	19	7,544	s.	34	s.	13	5	6	20	7.6	28.6	12.7
Northfield	876	12	60	28.95	29.95	−.10	13.0	−2.2	39	4	24	−25	30	2	38	10	8	89	3.74	+1.4	19	5,351	n.	30	sw.	23	6	7	18	7.1	31.5	23.4
Boston	124	336	360	------	29.90	−.15	28.2	+.3	54	3	35	4	30	21	32	----	----	71	6.46	+2.8	15	9,361	w.	40	ne.	19	14	4	13	5.1	12.7	4.0
Nantucket	12	14	90	29.90	29.91	−.13	31.4	+.1	51	3	37	11	28	26	28	28	24	78	4.92	+1.2	16	11,481	w.	46	se.	10	5	8	18	6.6	.7	T
Block Island	26	11	46	29.90	29.93	−.14	30.4	−.6	52	3	36	9	28	25	34	28	21	78	5.49	+1.7	14	14,430	w.	54	ne.	19	7	10	14	6.3	1.9	T
Providence	160	215	251	29.74	29.93	−.13	28.3	+1.1	53	3	35	6	24	21	36	24	18	69	6.84	+3.1	12	9,875	nw.	40	nw.	16	16	4	11	4.5	12.0	6.3
Hartford	159	70	104	29.79	29.98	−.09	27.2	+1.7	53	3	34	3	23	21	37	----	----	----	6.95	+3.0	13	6,767	nw.	30	nw.	16	13	4	14	5.5	15.2	8.0
New Haven	106	74	153	29.85	29.98	−.10	28.2	.0	53	3	35	1	23	22	39	24	18	68	7.56	+3.6	12	7,290	nw.	35	ne.	19	10	9	12	5.6	11.2	4.9
Middle Atlantic States							29.5	−2.8										73	5.96	+2.7										6.3		
Albany	97	97	112	29.88	29.99	−.08	23.6	+.5	45	3	30	−6	26	17	23	20	15	72	4.59	+2.2	16	5,877	nw.	28	s.	13	9	7	15	6.3	22.7	9.2
Binghamton	871	57	79	29.03	30.00	−.08	22.1	−2.0	44	13	29	−8	30	15	32	----	----	----	3.12	+.7	18	5,726	w.	28	sw.	23	1	6	24	8.5	17.9	7.4
New York	314	415	454	29.63	29.99	−.11	29.9	−1.0	53	15	37	−2	23	23	28	26	20	69	6.82	+3.2	13	12,415	nw.	49	s.	3	10	8	13	5.6	9.1	3.1
Harrisburg	374	94	104	29.61	30.03	−.07	25.6	−3.4	44	13	32	−6	23	19	38	22	16	70	5.58	+2.5	17	5,905	w.	30	w.	22	7	11	13	6.4	24.4	8.5
Philadelphia	114	174	367	29.90	30.03	−.08	29.9	−2.7	52	13	36	−2	23	24	26	26	20	67	6.44	+3.1	16	9,336	nw.	38	sw.	13	9	10	12	5.7	4.9	.5
Reading	323	283	306	29.67	30.04	------	27.1	−2.3	48	13	34	−5	23	21	32	24	17	68	5.29	+1.7	15	9,461	nw.	42	nw.	23	7	9	15	6.5	13.8	5.8
Scranton	805	72	104	29.10	30.00	−.09	24.0	−2.6	46	3	30	−8	23	18	28	21	16	71	4.47	+1.4	16	4,953	sw.	24	se.	22	5	8	18	7.2	26.5	8.0
Atlantic City	52	37	172	29.96	30.02	−.09	31.2	−1.3	51	3	38	1	23	25	29	28	23	74	5.92	+2.4	12	12,494	w.	51	ne.	19	7	8	16	6.3	2.7	.1
Sandy Hook	22	10	57	29.96	29.99	------	29.0	------	52	13	35	0	23	24	27	26	23	81	5.78	+1.8	12	12,599	w.	51	w.	23	10	8	13	5.5	2.9	2.0
Trenton	190	88	106	29.80	30.02	------	27.8	−2.7	53	3	35	−3	23	21	30	25	20	75	6.00	+2.7	14	7,676	w.	35	ne.	19	8	13	10	5.7	3.9	2.6
Baltimore	123	100	215	29.91	30.05	−.07	30.8	−3.0	55	13	37	0	23	24	34	27	20	68	5.94	+2.4	14	8,115	sw.	42	sw.	23	9	7	15	5.9	2.2	.2
Washington	112	62	85	29.93	30.06	−.07	30.6	−2.8	58	13	37	0	23	24	37	27	20	68	5.87	+2.3	15	6,123	nw.	38	nw.	23	8	10	13	6.0	2.3	.3
Cape Henry	18	8	54	30.02	30.04	------	36.8	−3.4	72	19	44	12	23	30	40	33	30	81	6.46	+3.3	12	9,110	nw.	51	nw.	23	9	7	15	5.9	9.6	3.8
Lynchburg	686	5	----	29.30	30.07	−.06	32.4	−5.1	63	13	42	−1	23	23	46	----	----	----	9.46	+6.0	13	------	nw.	----	------	---	6	17	8	----	2.0	.0
Norfolk	91	80	125	29.96	30.06	−.07	37.4	−3.2	72	19	44	10	23	30	40	33	28	74	6.60	+3.5	12	7,320	w.	39	w.	19	8	7	16	6.5	8.3	2.0
Richmond	144	11	52	29.91	30.07	−.07	33.0	−4.9	59	13	40	6	23	25	28	29	25	78	7.76	+4.6	12	5,994	n.	38	nw.	23	9	8	14	6.1	3.0	.7
Wytheville	2,304	49	55	------	30.06	−.08	29.2	−3.8	55	16	38	−7	23	20	38	----	----	80	5.19	+2.1	14	5,959	w.	34	w.	22	9	6	16	----	4.0	.5

TABLE 1.—*Climatological data for Weather Bureau stations, January 1936*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Total	Departure from normal	Days with 0.01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
South Atlantic States							**43.1**	**-2.4**										**77**	**5.56**	**+2.0**										**5.4**		
Asheville	2,253	89	104	27.64	30.08	-0.07	33.4	-2.0	63	16	43	1	23	24	38	29	24	74	7.15	+4.0	13	7,319	n.	31	nw.	19	11	6	14	5.9	3.8	0.4
Charlotte	779	63	86	29.20	30.06	-.09	37.7	-3.5	65	19	46	9	31	29	37	33	28	73	10.39	+6.4	14	5,516	ne.	46	sw.	19	12	6	13	5.5	4.7	2.0
Greensboro	886	6	56	29.08	30.06	------	33.4	------	59	19	43	3	27	24	33	29	25	79	8.08	------	13	5,939	sw.	35	sw.	19	10	8	13	5.6	4.9	1.5
Hatteras	11	5	50	30.04	30.05	-.09	43.1	-4.0	70	19	50	19	28	36	28	40	38	87	4.19	-.2	12	10,744	nw.	48	nw.	23	12	6	13	5.2	7.5	6.4
Raleigh	376	103	146	29.64	30.06	-.07	38.2	-2.9	69	19	47	9	28	30	38	34	30	79	6.62	+3.0	12	6,726	nw.	36	sw.	19	13	5	13	5.6	5.1	3.0
Wilmington	72	73	107	30.01	30.08	-.06	44.2	-2.3	71	19	53	18	31	35	31	39	34	75	4.00	+.7	11	7,203	nw.	47	sw.	19	13	8	10	4.7	6.5	4.6
Charleston	48	11	92	30.03	30.08	-.07	47.1	-2.8	70	19	55	23	28	39	34	43	39	79	2.54	-.5	11	7,509	w.	36	s.	19	12	5	14	5.5	.0	.0
Columbia, S. C.	347	67	73	29.69	30.08	-.07	43.0	-3.0	72	18	52	15	31	34	37	37	32	70	5.96	+2.5	15	5,039	nw.	43	sw.	19	15	5	11	5.0	6.2	3.2
Greenville, S. C.	1,039	139	------	------	------	------	37.9	-2.4	64	14	47	10	31	28	40	------	------	------	9.26	+4.4	13	------	ne.	------	------	------	16	2	13	------	4.8	2.9
Augusta	182	62	77	29.86	30.06	-.10	44.4	-2.6	73	18	54	17	31	34	39	39	33	71	6.00	+2.1	14	4,657	nw.	41	sw.	19	11	8	12	5.3	2.9	1.5
Savannah	65	73	152	30.00	30.08	-.07	50.5	-.9	75	7	60	22	28	41	37	44	41	79	3.27	+.5	14	7,919	nw.	43	w.	19	15	2	14	5.3	.0	.0
Jacksonville	43	86	110	30.04	30.09	-.06	54.9	-.5	80	6	64	24	28	45	32	49	45	78	1.82	-1.0	11	5,827	s.	35	s.	19	9	7	15	6.0	T	.0
Florida Peninsula							**67.2**	**+1.7**										**81**	**3.16**	**+0.8**										**4.7**		
Key West	22	10	64	30.02	30.04	-.06	71.0	+1.5	83	14	76	56	31	66	16	65	64	84	2.09	+.1	4	7,403	ne.	28	w.	19	20	7	4	3.4	.0	.0
Miami	25	124	168	30.05	30.08	-.05	68.8	+2.3	83	15	75	45	31	63	23	63	60	78	3.93	+1.4	6	7,984	se.	30	sw.	19	12	13	6	4.8	.0	.0
Tampa	35	88	197	30.04	30.08	-.04	61.8	+1.4	83	7	70	35	31	54	31	56	54	82	3.45	+.8	8	8,121	s.	33	sw.	19	7	11	13	5.9	.0	.0
Titusville	43	5	36	30.02	30.07	------	60.4	------	84	6	70	31	31	50	35	------	------	------	3.93	------	9	------	se.	------	------	------	10	11	10	------	.0	.0
East Gulf States							**46.8**	**-1.3**										**78**	**9.56**	**+4.8**										**5.1**		
Atlanta [1]	976	5	53	29.01	30.07	-.08	39.0	-3.6	71	18	49	5	31	29	35	34	30	78	10.82	+5.9	15	7,252	nw.	48	w.	19	13	5	13	5.4	8.0	4.2
Macon	370	79	87	29.67	30.08	-.08	44.4	-2.4	70	18	55	16	31	34	38	39	34	73	9.19	+5.0	17	5,373	nw.	38	s.	18	11	7	13	5.5	3.1	.0
Thomasville	273	49	58	29.80	30.10	-.06	52.4	+1.4	76	8	62	20	28	43	31	48	46	90	6.47	+2.4	16	------	sw.	------	------	------	11	4	16	------	.0	.0
Apalachicola	35	11	51	30.04	30.08	------	53.8	------	71	15	60	28	28	47	27	49	------	------	4.60	+1.0	13	------	e.	45	w.	19	9	8	14	------	.0	.0
Pensacola	56	149	185	30.01	30.07	-.07	53.2	+.7	73	6	60	24	28	46	34	50	47	84	16.30	+12.3	14	9,843	n.	50	s.	18	9	9	13	5.5	T	.0
Anniston	741	9	------	------	------	------	41.4	-.8	74	17	52	2	31	31	36	------	------	------	11.37	+6.2	17	------	nw.	------	------	------	14	5	12	------	10.0	8.0
Birmingham	700	11	48	29.29	30.07	-.09	41.6	-3.5	75	17	51	8	31	32	32	37	32	73	10.07	+4.6	17	6,184	nw.	27	se.	2	12	7	12	5.3	11.8	8.0
Mobile	57	86	105	30.00	30.06	-.09	51.4	-.1	77	6	60	23	28	43	30	47	44	79	14.59	+9.7	17	6,333	n.	28	nw.	19	10	8	13	5.4	T	.0
Montgomery	218	92	106	29.83	30.09	-.07	47.2	-1.0	77	17	56	19	28	38	29	42	37	73	12.14	+6.9	14	5,960	n.	30	w.	19	12	6	13	5.4	.3	.0
Meridian	375	67	92	29.66	30.07	-.09	44.4	-2.6	77	17	55	16	28	34	37	40	35	76	6.82	+1.5	15	5,126	ne.	22	nw.	6	13	7	11	4.8	1.4	T
Vicksburg	247	65	73	29.82	30.08	-.07	45.4	-2.8	76	17	54	19	28	37	36	40	35	74	3.60	-1.8	13	5,891	n.	26	nw.	6	9	9	13	6.0	3.0	T
New Orleans	53	76	84	30.00	30.06	-.07	54.5	+.3	79	6	62	29	28	46	34	50	47	82	8.78	+4.4	11	5,629	ne.	25	nw.	19	11	5	15	6.2	T	.0
West Gulf States							**46.6**	**-1.8**										**72**	**1.14**	**-1.7**										**4.8**		
Shreveport	249	92	227	29.80	30.08	-.06	44.6	-2.4	76	17	54	17	19	35	32	39	34	71	1.77	-2.2	7	8,300	ne.	31	s.	3	12	11	8	4.7	4.6	T
Bentonville	1,303	12	38	28.64	30.05	-.09	32.0	-2.1	68	12	41	2	27	23	30	------	------	------	.32	-2.4	5	6,684	nw.	24	sw.	13	7	7	17	------	1.1	.4
Fort Smith	457	79	94	29.57	30.07	-.07	37.0	-2.5	72	12	46	14	27	28	31	32	26	69	.22	-2.3	7	6,643	e.	29	w.	17	9	13	9	5.5	2.0	.0
Little Rock	357	94	102	29.70	30.10	-.05	38.2	-3.2	71	12	47	10	24	30	31	33	26	66	.93	-3.8	6	6,403	e.	25	sw.	12	9	11	11	5.3	1.4	T
Austin	605	136	148	29.41	30.05	------	49.4	-.1	82	16	62	23	20	37	38	41	33	61	.39	-1.7	4	6,183	n.	28	nw.	18	15	10	6	4.1	T	.0
Brownsville	57	88	96	29.94	30.00	------	57.4	-2.4	83	15	66	32	19	49	37	53	50	84	.41	-1.1	10	8,448	nw.	38	s.	17	12	4	15	6.0	.0	.0
Corpus Christi	20	11	78	30.02	30.04	-.06	54.4	-1.6	86	17	63	29	19	46	34	50	47	83	.61	-1.0	8	7,587	n.	31	n.	18	13	5	13	5.3	.0	.0
Dallas	512	220	227	29.49	30.06	------	43.6	------	79	12	54	14	19	33	33	37	30	54	.48	-1.9	3	9,058	n.	31	nw.	18	15	8	8	4.2	3.6	.4
Fort Worth	679	92	110	29.34	30.07	-.05	44.0	-1.4	80	12	55	16	19	33	40	------	------	------	.67	-1.4	4	7,363	n.	31	nw.	12	22	1	8	3.3	4.5	T
Galveston	54	106	114	30.00	30.05	-.08	52.0	-1.8	70	17	58	28	19	46	35	49	47	87	2.75	-.7	14	8,180	n.	40	nw.	18	11	7	13	5.3	.0	.0
Houston	138	292	314	29.91	30.06	------	51.3	-1.4	81	16	60	23	19	42	39	------	------	------	1.94	-1.8	14	9,091	n.	40	nw.	18	14	3	14	5.3	.0	.0
Palestine	510	64	72	29.52	30.07	-.05	46.4	-1.8	75	11	57	17	19	36	36	40	34	68	.42	-3.0	3	6,260	s.	24	sw.	17	15	6	10	4.5	2.6	T
Port Arthur	34	58	66	30.02	30.06	------	51.2	------	73	17	59	25	19	43	36	------	------	------	4.63	+.9	14	6,805	n.	31	nw.	18	13	5	13	5.4	T	.0
San Antonio	693	242	301	29.30	30.03	-.07	52.0	-.3	84	16	63	25	19	41	32	44	36	62	.43	-1.0	7	8,429	ne.	38	nw.	18	14	12	5	4.0	T	.0
Ohio Valley and Tennessee							**28.0**	**-5.6**										**77**	**3.20**	**-0.7**										**7.0**		
Chattanooga	762	71	214	29.25	30.09	-0.07	37.6	-3.6	71	17	46	5	27	29	36	34	28	71	9.62	+4.4	16	6,225	w.	34	w.	22	10	10	11	5.6	6.4	2.8
Knoxville	995	66	84	28.99	30.08	-.07	34.8	-4.0	64	17	43	2	27	26	40	32	28	80	7.84	+3.2	13	4,682	w.	25	w.	22	12	6	13	6.0	5.5	1.7
Memphis	399	78	86	29.65	30.09	-.07	36.4	-4.5	69	17	44	6	27	29	38	32	26	68	2.19	-2.6	9	6,510	n.	26	n.	22	11	7	13	5.6	2.4	.0
Nashville	546	168	191	29.51	30.12	-.04	33.0	-5.6	68	17	42	-3	27	24	45	29	26	76	3.52	-1.2	15	7,368	nw.	32	nw.	19	8	6	17	6.5	9.2	.2
Lexington	989	6	------	------	------	------	26.8	-6.1	58	14	34	-15	23	20	32	------	------	------	4.00	-1.8	16	------	sw.	------	------	------	13	4	14	------	15.6	6.0
Louisville	525	188	234	29.50	30.11	-.03	27.8	-6.6	60	12	36	-11	23	20	46	24	19	73	1.59	-2.4	12	8,048	sw.	38	nw.	22	7	9	15	6.7	6.1	1.6
Evansville	431	76	116	29.61	30.10	-.04	27.9	-5.6	62	12	35	-8	27	21	43	24	20	73	1.80	-1.9	12	7,204	nw.	34	nw.	22	5	7	19	6.9	5.3	2.8
Indianapolis	822	194	230	29.14	30.07	-.05	22.2	-6.2	57	12	30	-18	23	15	49	20	15	77	1.32	-1.6	12	8,840	w.	39	w.	22	3	10	18	7.6	7.1	3.1
Terre Haute	575	96	129	29.42	30.07	------	23.6	------	60	12	31	-15	23	16	48	21	17	80	1.43	-1.3	15	7,445	w.	35	nw.	22	8	8	15	6.4	7.8	3.6
Cincinnati	627	11	51	29.37	30.08	-.04	25.2	-5.1	57	14	33	-16	23	17	47	22	17	75	1.28	-2.2	13	6,564	sw.	28	sw.	13	4	7	20	7.5	9.9	2.2
Columbus	822	90	210	29.14	30.06	-.05	23.8	-4.8	50	14	31	-16	22	17	49	22	18	78	1.26	-1.8	14	7,961	sw.	37	w.	22	2	12	17	7.6	12.1	2.6
Dayton	900	58	153	29.01	30.04	------	23.4	-6.1	53	14	31	-16	23	16	47	------	------	------	1.47	-1.8	12	7,289	sw.	34	nw.	22	2	12	17	7.5	10.4	1.4
Elkins	1,947	59	78	27.93	30.09	-.03	25.2	-5.2	56	14	34	-16	23	16	45	23	20	84	4.74	+1.0	22	5,435	w.	32	w.	22	3	8	20	8.0	12.8	3.8
Parkersburg	637	77	84	29.41	30.10	-.02	25.8	-6.7	56	14	34	-16	23	17	54	23	21	84	2.49	-1.1	17	5,382	sw.	35	nw.	22	3	6	22	8.1	18.6	7.3
Pittsburgh [1]	842	164	410	28.61	30.02	-.09	22.6	-8.1	51	13	30	-16	23	15	49	20	18	85	3.50	+.4	16	8,887	sw.	40	w.	13	1	7	23	8.3	20.9	7.7
Lower Lake Region							**21.8**	**-2.7**										**83**	**1.96**	**-0.6**										**8.4**		
Buffalo	768	243	280	29.11	29.97	-.10	23.2	-1.4	46	13	28	-3	27	18	24	21	19	85	2.26	-1.0	24	13,678	sw.	56	w.	13	2	5	24	8.6	20.0	8.6
Canton	448	10	61	29.46	29.97	------	14.2	-2.1	42	13	22	-15	26	7	38	13	12	93	2.27	-.2	15	6,336	w.	37	w.	13	2	9	20	7.7	15.4	6.8
Ithaca	836	77	100	29.04	29.98	------	22.8	-1.5	41	13	29	-3	23	17	29	20	16	78	2.08	-.1	20	8,240	w.	35	se.	9	4	4	23	8.3	15.9	8.4
Oswego	335	71	85	29.59	29.97	-.10	22.4	-1.5	42	13	28	-2	30	17	30	20	17	79	2.30	-.6	17	9,518	se.	37	w.	23	1	3	27	8.9	21.5	11.7
Rochester	523	86	102	29.39	29.98	-.09	23.3	-1.3	43	13	28	-2	27	19	34	21	16	74	2.88	.0	22	7,904	w.	34	w.	23	0	4	27	9.0	28.0	13.0
Syracuse	596	65	79	29.33	30.00	-.07	23.3	+.3	44	15	29	0	30	18	30	------	------	------	3.18	+.2	21	6,284	w.	25	w.	23	2	4	25	8.8	26.4	11.0
Erie	714	130	166	29.20	29.99	-.09	23.6	-3.2	50	13	30	-7	23	18	36	22	18	82	1.58	-1.2	19	11,334	sw.	42	sw.	22	2	3	26	8.8	11.7	6.0
Cleveland	762	267	318	29.15	30.00	-.09	23.8	-2.7	51	13	31	-10	22	17	44	22	19	84	1.41	-1.1	17	12,426	sw.	43	w.	13	3	4	24	8.4	11.2	2.4
Sandusky	629	5	67	29.32	30.03	-.06	22.4	-3.9	48	14	29	-12	22	16	38	------	------	------	1.07	-1.2	14	7,957	sw.	28	sw.	22	4	5	22	7.8	8.7	1.4
Toledo	628	79	87	29.32	30.03	-.06	20.9	-4.9	48	14	27	-12	22	14	32	19	16	82	1.40	-.8	15	8,537	w.	30	w.	22	4	3	24	8.0	8.4	2.0
Fort Wayne	857	69	84	29.08	30.04	------	19.7	-7.2	50	14	26	-18	22	13	38	18	15	86	1.55	-.8	12	7,824	w.	30	w.	22	4	9	18	7.2	7.8	2.3
Detroit	626	5	78	29.29	30.00	-.08	21.6	-2.8	46	13	28	-6	27	16	24	20	17	83	1.48	-.6	16	8,742	w.	34	sw.	21	0	5	26	8.7	10.1	1.5

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, January 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Upper Lake Region							**15.9**	**−2.5**										**84**	**2.02**	**+0.2**										**7.7**		
Alpena	609	13	89	29.29	29.98	−0.06	18.8	−0.3	36	3	25	−5	23	13	26	17	14	84	1.90	+0.1	18	7,916	nw.	34	nw.	13	1	10	20	8.0	23.7	14.4
Escanaba	612	54	60	29.32	30.02	−.03	15.4	.0	35	3	21	−14	26	9	23	14	11	86	1.60	+.1	13	6,883	nw.	32	n.	22	2	10	19	8.1	16.8	7.0
Grand Rapids	707	70	244	29.20	30.00	−.06	21.4	−3.1	44	14	26	−1	22	16	19	20	17	83	2.13	−.2	19	8,397	sw.	31	w.	13	1	1	29	9.3	24.3	11.1
Lansing	878	6	88	29.02	30.00	......	19.4	−3.0	41	12	26	−9	27	13	25	18	16	88	1.78	.0	15	7,445	sw.	30	w.	13	0	2	29	9.2	17.2	10.2
Ludington	637	5	54	29.27	29.99	......	21.0	−2.1	41	14	26	−6	31	16	21	20	......	......	2.18	.0	21	......	w.	......	......	......	0	6	25	......	26.9	14.5
Marquette	734	77	111	29.16	30.00	−.04	16.2	−.1	36	1	21	−8	24	12	15	15	13	90	2.87	+.5	20	7,480	w.	28	w.	23	0	4	27	9.0	28.1	20.0
Sault Ste. Marie	614	11	52	29.27	30.01	−.02	12.8	−.5	35	3	19	−17	23	6	27	12	11	91	2.59	+.6	24	5,306	se.	32	nw.	23	2	8	21	8.2	33.6	14.9
Chicago	673	7	131	29.29	30.05	−.05	19.0	−4.7	49	12	25	−17	23	13	30	17	13	77	1.64	−.3	12	8,260	w.	28	nw.	22	9	6	16	6.7	11.6	1.9
Green Bay	617	109	141	29.32	30.02	−.04	11.8	−3.9	36	12	20	−24	24	4	24	11	7	80	1.42	−.1	11	6,930	sw.	32	ne.	18	8	3	20	6.8	15.5	10.5
Milwaukee	681	97	221	29.26	30.03	−.05	16.2	−4.4	43	14	22	−21	22	10	28	15	10	76	2.54	+.8	14	9,814	w.	35	ne.	18	8	7	16	6.5	24.8	11.4
Duluth	1,133	5	47	28.76	30.06	−.03	2.6	−5.3	32	3	11	−35	23	−6	25	1	−2	83	1.53	+.6	9	9,858	nw.	36	nw.	26	12	6	13	5.0	18.1	12.2
North Dakota							**−5.7**	**−10.7**										**86**	**0.46**	**−0.1**										**6.3**		
Moorhead, Minn	940	50	58	29.08	30.18	+.07	−6.2	−10.0	25	10	3	−37	22	−15	27	−6	−7	97	.39	−.3	11	5,740	n.	20	nw.	3	5	12	14	6.4	6.3	7.7
Bismarck	1,674	8	57	28.24	30.16	+.03	−3.8	−11.6	30	3	5	−28	22	−13	34	−4	−10	72	.36	−.1	9	4,858	nw.	27	nw.	3	8	8	15	6.5	7.6	8.4
Devils Lake	1,478	11	44	28.47	30.19	+.07	−10.5	−12.3	26	10	−1	−37	22	−20	31	−11	−12	96	.36	−.1	9	5,681	nw.	23	e.	12	6	9	16	6.8	4.4	11.6
Grand Forks	833	12	67	......	......	......	−10.1	......	23	3	0	−39	22	−21	34	−11	......	......	.80	......	8	......	nw.	27	s.	8	2	22	7	......	10.5	14.5
Williston	1,878	41	48	28.03	30.15	+.04	−2.4	−8.8	31	2	6	−30	19	−11	36	−3	−7	79	.71	+.2	11	4,484	se.	21	nw.	3	11	7	13	5.5	7.2	11.8
Upper Mississippi Valley							**15.0**	**−6.7**										**84**	**1.44**	**−0.2**										**6.3**		
Minneapolis	918	102	208	29.05	30.09	......	3.8	−8.9	35	1	11	−34	22	−4	26	4	2	89	.77	−.1	13	7,318	nw.	34	nw.	22	11	4	16	6.2	9.1	8.0
La Crosse	714	11	48	29.27	30.09	−.02	9.6	−6.5	37	12	18	−28	22	2	28	8	6	87	.90	−.2	13	3,932	nw.	18	nw.	22	10	6	15	6.0	10.0	7.0
Madison	974	70	78	28.94	30.05	−.05	11.0	−5.7	42	14	18	−26	22	4	27	10	9	91	1.78	+.4	13	6,216	nw.	29	ne.	17	6	9	16	6.5	16.8	11.5
Charles City	1,015	10	51	28.96	30.11	−.03	6.0	−7.7	36	12	15	−29	22	−3	31	5	3	88	1.44	+.4	13	5,123	nw.	19	nw.	22	9	9	13	6.0	14.8	13.7
Davenport	606	66	161	29.40	30.10	−.02	14.6	−7.2	48	12	22	−22	22	8	35	13	10	82	1.44	.0	12	7,315	nw.	32	nw.	22	7	9	15	6.5	17.1	4.7
Des Moines	861	5	99	29.16	30.13	−.01	11.2	−8.9	41	12	19	−22	22	4	27	10	8	86	1.86	+.8	10	6,967	nw.	27	nw.	30	11	5	15	5.9	21.1	9.5
Dubuque	700	60	79	29.29	30.09	−.03	11.9	−7.2	43	14	19	−26	22	4	29	10	7	80	1.46	+.2	13	4,696	nw.	21	nw.	22	8	6	17	6.6	15.5	7.2
Keokuk	614	64	78	29.42	30.14	.00	17.2	−7.7	56	12	25	−18	22	9	40	15	12	81	1.74	+.2	16	6,202	nw.	28	nw.	22	11	8	12	5.8	14.6	9.6
Cairo	358	87	93	29.70	30.10	−.06	30.8	−4.1	66	12	38	−3	27	24	39	27	23	78	.95	−2.8	10	7,384	nw.	30	n.	18	4	7	20	7.3	1.4	.5
Peoria	609	11	45	29.40	30.10	−.02	17.2	−5.9	53	12	25	−20	23	10	38	15	13	84	1.79	.0	13	5,886	w.	35	nw.	22	10	9	12	5.9	15.4	3.9
Springfield, Ill	636	5	191	29.38	30.09	−.04	21.2	−5.3	59	12	28	−16	23	14	45	19	16	84	1.77	−.3	14	8,680	w.	36	nw.	22	8	5	18	6.6	13.0	3.5
St. Louis	568	179	303	29.46	30.09	−.05	25.4	−5.4	67	12	32	−10	23	18	48	23	18	76	1.32	−1.0	14	9,017	nw.	39	sw.	12	9	3	19	6.7	7.0	3.6
Missouri Valley							**16.7**	**−7.4**										**82**	**1.25**	**+0.2**										**6.0**		
Columbia, Mo	784	6	84	29.22	30.10	−.03	22.8	−6.4	64	12	31	−16	27	15	45	......	......	......	.93	−1.0	12	6,722	w.	25	nw.	22	10	7	14	5.6	8.5	4.8
Kansas City [1]	750	32	45	29.27	30.11	−.04	21.7	−6.5	56	13	30	−8	27	14	43	19	15	78	1.17	.0	10	7,386	nw.	32	n.	22	7	10	14	6.2	5.9	2.2
St. Joseph	967	11	49	29.02	30.11	......	16.8	......	51	13	25	−17	27	8	38	15	12	82	2.62	+1.6	11	6,369	nw.	26	nw.	3	14	7	10	4.7	24.0	9.6
Springfield, Mo	1,324	98	104	28.62	30.07	−.07	28.0	−5.5	68	12	36	−6	27	20	33	25	19	73	.17	−2.2	7	8,164	nw.	28	sw.	12	8	10	13	5.8	.6	T
Iola	984	11	50	29.00	30.09	−.05	28.0	−1.8	59	11	37	−3	27	19	35	......	......	......	1.08	−.2	4	......	n.	......	......	......	8	9	14	......	1.0	.0
Topeka	987	65	87	......	......	......	21.2	−6.4	56	13	30	−6	23	13	45	......	......	......	1.73	+.8	6	6,499	nw.	23	nw.	3	11	7	13	5.5	13.2	1.1
Lincoln	1,189	11	81	28.79	30.13	−.02	14.0	−8.8	47	13	23	−19	27	5	35	12	9	83	1.64	+1.0	10	6,348	n.	30	nw.	12	6	11	14	6.5	19.3	10.0
Omaha [1]	1,105	170	200	29.02	30.16	+.01	10.4	−11.5	44	10	19	−21	27	2	32	9	6	85	1.50	+.8	13	6,676	nw.	34	nw.	12	9	7	15	6.2	25.7	12.0
Valentine	2,598	47	54	27.26	30.13	+.01	13.2	−5.7	51	13	25	−21	27	1	37	11	8	83	.98	+.5	12	6,100	w.	24	nw.	12	7	12	12	6.7	13.2	12.2
Sioux City	1,138	64	106	28.84	30.14	−.01	6.8	−11.0	39	10	16	−21	22	−2	30	6	4	87	1.46	+.7	13	6,424	nw.	30	nw.	12	8	7	16	6.4	19.4	10.0
Huron	1,306	60	74	28.68	30.18	+.02	.5	−10.8	40	10	10	−26	22	−9	35	0	−2	87	.52	.0	11	5,725	nw.	28	nw.	3	9	7	15	6.0	7.3	5.2
Northern Slope							**19.1**	**−0.2**										**76**	**0.77**	**0.0**										**6.5**		
Missoula	3,263	80	91	......	......	......	26.8	......	44	2	33	−7	29	20	24	......	......	......	1.23	+.2	12	5,112	se.	27	se.	9	4	2	25	8.2	10.0	1.8
Havre	2,505	11	67	27.33	30.11	+.01	9.6	−3.3	46	22	20	−24	19	−1	51	8	6	90	.51	−.2	10	6,582	e.	30	sw.	28	7	10	14	6.5	8.1	2.2
Helena	4,124	85	111	25.72	30.05	−.10	23.2	+3.0	51	22	30	−9	29	16	23	20	15	69	.57	−.3	8	5,450	sw.	31	sw.	21	3	4	24	8.0	10.8	2.8
Kalispell	2,973	48	56	......	30.01	−.11	25.0	+4.6	46	22	32	−4	29	18	25	......	......	86	1.93	+.4	13	3,745	nw.	21	sw.	11	3	9	19	......	20.3	7.5
Miles City	2,371	48	55	27.45	30.13	+.01	10.8	−3.7	46	13	20	−20	19	1	37	9	5	76	.58	−.1	12	4,140	ne.	25	n.	24	7	8	16	6.8	8.3	5.7
Rapid City	3,259	50	58	26.53	30.13	+.03	16.8	−5.2	55	13	28	−12	18	6	41	14	10	80	.51	+.1	10	4,885	se.	28	n.	24	8	10	13	5.8	8.2	4.7
Cheyenne	6,094	50	71	23.79	30.00	−.05	25.4	−.1	58	11	36	−10	29	14	40	20	13	63	.30	−.1	9	12,528	nw.	54	nw.	2	10	12	9	5.2	3.8	T
Lander	5,372	60	68	24.52	30.05	−.07	22.6	+4.3	52	22	35	−13	8	10	45	18	14	76	.26	−.3	4	4,019	sw.	40	sw.	13	11	15	5	4.6	2.9	.0
Sheridan	3,790	10	47	25.99	30.04	......	19.5	......	57	11	31	−13	29	8	44	16	16	69	.76	−.1	10	4,033	nw.	32	nw.	11	4	11	16	6.6	10.8	1.0
Yellowstone Park	6,241	12	46	23.76	30.11	−.03	17.0	−.6	38	11	26	−14	29	8	30	15	11	76	1.31	−.3	20	6,293	sw.	30	sw.	11	5	5	21	7.3	32.1	12.5
North Platte	2,821	11	51	27.02	30.08	−.04	21.7	−1.2	63	11	33	−7	18	10	43	18	14	77	.48	+.1	8	5,088	w.	25	n.	12	8	9	14	6.0	5.0	1.0
Middle Slope							**29.8**	**−0.6**										**66**	**0.49**	**−0.1**										**5.2**		
Denver	5,292	106	113	24.60	29.97	−0.08	32.2	+2.4	67	11	43	4	29	21	38	26	14	49	0.40	0.0	7	6,513	s.	32	nw.	24	9	12	10	5.5	6.1	0.0
Pueblo	4,685	80	86	25.19	29.98	−.07	33.4	+3.5	67	11	46	2	18	21	40	26	15	53	.23	−.1	5	6,622	nw.	45	w.	15	10	15	6	4.7	2.9	.0
Concordia	1,392	50	58	28.59	30.13	−.01	22.0	−4.4	54	11	30	−2	23	14	36	19	16	83	.69	+.1	7	5,903	n.	26	nw.	12	12	9	10	5.5	6.0	T
Dodge City	2,509	10	86	27.39	30.00	−.02	28.4	−.6	61	22	39	4	30	18	41	24	20	74	.59	+.2	7	7,947	n.	30	n.	12	14	7	10	4.6	6.9	T
Wichita	1,358	85	93	28.59	30.08	−.05	28.0	−3.3	59	13	36	2	27	20	31	25	19	70	.94	+.2	3	7,681	n.	26	sw.	13	10	9	12	5.6	4.1	.0
Oklahoma City	1,214	10	47	28.75	30.07	−.04	35.0	−1.4	69	12	45	12	26	25	36	29	23	68	.09	−1.1	4	7,569	n.	25	nw.	12	12	7	12	5.3	.3	T
Southern Slope							**42.0**	**−0.7**										**60**	**0.73**	**+0.1**										**4.4**		
Abilene	1,738	10	52	28.21	30.06	−.03	43.4	−.8	76	12	56	9	19	31	39	34	24	54	.60	−.4	2	7,428	s.	25	s.	4	15	7	9	4.3	3.8	T
Amarillo	3,676	10	49	26.22	30.03	−.03	35.6	+.3	69	15	46	11	30	25	36	29	22	66	1.02	+.5	6	6,939	w.	23	w.	12	10	13	8	4.9	10.3	.0
Del Rio	944	64	71	29.02	30.02	−.04	50.2	−2.1	83	16	64	23	19	37	41	41	32	59	.33	−.2	3	5,594	se.	37	nw.	18	16	9	6	3.8	.0	.0
Roswell	3,566	75	85	26.36	30.04	.00	39.0	−.2	72	15	52	10	19	26	46	31	23	60	.98	+.4	4	5,685	s.	34	nw.	3	16	10	5	4.4	9.7	2.7

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, January 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Southern Plateau							44.8	+1.3										53	0.53	−0.1										3.7		
El Paso	3,778	152	175	26.18	30.02	+.01	45.5	+.5	69	16	57	24	20	34	35	36	23	46	.57	+.1	1	6,876	nw.	37	w.	16	18	7	6	3.4	T	.0
Albuquerque	4,972	5	39	25.03	30.07		32.6		64	15	46	10	7	19	41	26	20	68	.55	+.2	4	5,132	n.	35	nw.	3	11	11	9	4.6	6.8	.0
Santa Fe	7,013	38	53	23.16	30.06	+.02	28.2	−.6	52	15	38	8	19	18	28	24	18	68	.99	+.3	5	4,654	n.	24	n.	12	18	8	5	3.6	11.4	3.5
Flagstaff	6,907	10	59																													
Phoenix	1,108	10	107	28.85	30.02	−.01	52.8	+1.6	76	27	67	30	19	38	39	41	27	42	.80	.0	2	3,662	e.	18	nw.	17	15	11	5	3.8	.0	.0
Yuma	141	9	54	29.89	30.04	−.01	55.4	+1.0	76	15	68	34	2	43	34	44	30	42	.24	−.2	2	4,250	n.	22	n.	19	15	13	3	3.2	.0	.0
Independence	3,957	5	26	26.00	30.08	+.01	42.3	+4.1	70	15	55	22	12	29	38	32			.02	−.9	1		nw.				21	5	5		T	.0
Middle Plateau							31.6	+3.4										70	0.85	−0.1										5.8		
Reno	4,527	61	76	25.49	30.10	−.03	38.0	+5.5	56	10	48	16	30	28	31	32	25	60	.62	−.9	6	5,216	w.	32	w.	14	8	11	12	5.7	T	.0
Tonopah	6,090	12	20				34.0		54	15	42	14	18	26	33	28	19	59	.02		1		se.									
Winnemucca	4,344	18	56	25.63	30.10	−.06	34.0	+5.4	51	10	43	12	1	25	30	30	27	78	1.34	+.3	12	6,469	sw.	30	sw.	15	7	3	21	7.1	1.1	.0
Modena	5,473	10	46	24.61	30.06	−.04	29.8	+3.1	58	27	43	5	30	16	44	25	19	66	.06	−.8	2	7,118	sw.	32	sw.	11	15	8	8	4.2	.2	.0
Salt Lake City [1]	4,357	86	210	25.74	30.11	−.04	29.0	−.2	52	15	37	5	18	21	26	27	24	84	2.02	+.7	13	6,642	se.	34	nw.	11	6	9	16	6.9	10.4	2.2
Grand Junction	4,602	60	68	25.39	30.06	.00	27.4	+3.4	51	16	37	3	2	18	26	24	20	76	.22	−.4	6	3,338	n.	21	nw.	16	11	9	11	5.2	2.2	.0
Northern Plateau							30.7	+2.9										79	2.53	+0.8										8.1		
Baker	3,471	48	53	26.45	30.12	−.04	26.3	+1.4	46	11	34	−3	29	19	27	24	21	76	2.44	+1.0	20	4,767	se.	21	w.	11	4	4	23	7.8	25.0	2.8
Boise	2,739	79	87	27.23	30.16	−.03	31.6	+1.8	55	11	38	4	31	26	22	29	25	77	2.13	+.4	19	4,653	se.	21	se.	3	2	3	26	8.4	9.7	2.5
Pocatello	4,477	60	68	25.47	30.13	−.07	24.0	−.7	45	11	32	−7	31	16	31	23	19	79	2.46	+1.1	16	7,154	w.	36	s.	11	2	6	23	8.0	17.3	2.1
Spokane	1,929	101	110	27.93	30.03	−.09	31.8	+4.3	44	15	37	5	29	27	19	30	28	83	2.78	+.6	15	4,267	s.	24	s.	12	4	6	21	7.8	11.3	1.4
Walla Walla	991	57	65	28.95	30.04	−.11	37.5	+4.8	55	12	42	10	30	33	19	35	31	77	3.21	+1.2	15	4,650	s.	24	w.	5	1	5	25	9.0	6.3	4.1
Yakima	1,076	58	67	28.85	30.03		33.0	+5.6	52	13	39	11	29	27	21	31	28	83	2.14	+.8	10	3,101	nw.	25	sw.	11	5	6	20	7.7	11.2	.3
North Pacific Coast Region							44.6	+3.9										82	8.83	+2.1										8.0		
North Head	211	11	56	29.72	29.95	−.10	45.2	+3.1	55	21	50	32	30	41	16	43	40	83	10.46	+1.7	24	12,194	e.	73	s.	12	4	2	25	8.0	T	.0
Seattle	125	90	321	29.81	29.94	−.11	44.2	+4.7	56	22	48	29	30	40	17	41	38	78	7.17	+2.2	19	7,829	e.	40	sw.	4	5	8	18	7.1	.0	.0
Tatoosh Island	86	10	54	29.80	29.90	−.08	44.9	+3.7	51	23	48	37	30	42	11	42	39	82	10.94	−.9	24	13,949	e.	52	e.	10	4	4	23	7.8	.0	.0
Medford	1,329	29	58	28.64	30.08		40.6		62	10	47	22	31	34	31	39	37	88	6.67	+3.9	20		n.				3	4	24	8.4	T	.0
Portland, Oreg.	153	68	106	29.84	30.00	−.08	44.2	+4.8	55	2	48	27	30	40	15	41	37	78	8.55	+2.0	20	5,710	se.	30	sw.	12	3	4	24	8.1	.0	.0
Roseburg	510	45	76	29.48	30.04	−.06	44.4	+3.2	61	22	51	26	30	38	31	42	40	84	9.17	+3.9	20	3,206	sw.	27	w.	3	1	7	23	8.6	.0	.0
Middle Pacific Coast Region							51.1	+3.6										76	6.14	+1.0										6.8		
Eureka	62	73	89	30.01	30.08	−.02	49.6	+2.7	70	29	55	38	17	44	28	48	45	86	8.84	+1.7	21	5,932	se.	34	sw.	15	6	3	22	7.7	.0	.0
Redding	722	20	34				49.0		68	22	56	33	17	42	28	43	36	66	12.50		14	6,431	nw.	36	s.	10	7	5	19	7.0	T	.0
Sacramento	69	92	115	30.02	30.10	−.02	50.0	+4.2	66	28	57	35	20	43	25	47	43	77	3.80	+.1	12	5,647	se.	24	se.	8	10	8	10	6.0	.0	.0
San Francisco	155	208	243	29.92	30.09	−.02	53.8	+3.9	66	28	59	42	20	49	18	49	44	73	5.77	+1.2	12	4,652	n.	28	nw.	16	9	4	18	6.7	.0	.0
South Pacific Coast Region							55.5	+3.8										65	0.65	−1.6										5.7		
Fresno	327	97	105	29.76	30.12	+.02	50.5	+4.3	70	25	60	34	6	42	31	48	44	78	.68	−1.0	10	3,652	e.	19	sw.	11	12	3	16	5.9	.0	.0
Los Angeles	338	159	191	29.68	30.05	−.03	59.4	+4.8	79	26	68	44	25	51	27	48	37	51	.51	−2.6	5	4,260	ne.	25	nw.	17	12	11	8	4.8	.0	.0
San Diego	87	62	70	29.94	30.04	−.03	56.6	+2.3	73	27	64	43	18	49	25	49	43	66	.75	−1.3	3	3,766	nw.	18	nw.	12	8	8	15	6.4	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.93	30.02		75.2	+.2	86	31	80	67	22	70	16				2.47	−1.7	14	8,698	e.	35	e.	6	8	21	2	4.8	.0	.0
Panama Canal																																
Balboa Heights	118	6	92		[3] 29.80	−.04	80.2	+.3	91	30	88	69	7	72	19			[2] 76	.83	−.1	3	6,391	nw.	24	nw.	29	4	27	0	4.6	.0	.0
Cristobal	36	6	97		[3] 29.83	−.03	81.2	−.3	86	20	84	75	12	78	9	75	73	[2] 77	1.54	−1.9	13	9,566	n.	24	n.	28	6	20	5	5.4	.0	.0
Alaska																																
Fairbanks	454	11	87		[3] 29.88		−8.2		36	25	1	−44	4	18	38			80	.09		2	3,042	nw.	17	ne.	24	12	12	7		2.4	15.2
Juneau	80	96	116	[3] 29.76	[3] 29.85		26.6		42	20	30	10	14	23	15	25	22	81	4.86		18	4,707	s.	25	e.	12	4	4	23	8.3	30.3	7.2
Hawaiian Islands																																
Honolulu	38	86	100	[3] 29.91	[3] 29.95		73.6	+2.7	82	20	78	64	23	69	14	67	64	74	2.81	−1.0	10	6,281	e.	26	w.	31	13	11	7	4.6	.0	.0

[1] Observations taken at airport.
[2] Observations taken bihourly.
[3] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, January 1936*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Ft.	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48												
Halifax, Nova Scotia	88												
Yarmouth, Nova Scotia	65												
Charlottetown, Prince Edward Island	38												
Chatham, New Brunswick	28												
Father Point, Quebec	20												
Quebec, Quebec	296												
Doucet, Quebec	1,236												
Montreal, Quebec	187												
Ottawa, Ontario	236	29.64	29.92	−0.11	17.2	+7.6	23.5	10.8	39	−10	2.77	−0.22	20.5
Kingston, Ontario	285												
Toronto, Ontario	379	29.55	29.98	−.07	22.4	+1.0	27.8	17.0	41	−2	2.14	−.78	12.1
Cochrane, Ontario	930												
White River, Ontario	1,244												
London, Ontario	808				18.7		24.7	12.8	40	−7	2.16		19.4
Southampton, Ontario	656												
Parry Sound, Ontario	688												
Port Arthur, Ontario	644												
Winnipeg, Manitoba	700												
Minnedosa, Manitoba	1,690												
Le Pas, Manitoba	860				17.4		−9.5	−25.3	15	−43	.50		5.0
Qu'Appelle, Saskatchewan	2,115												
Moose Jaw, Saskatchewan	1,759				−5.0		2.4	−12.4	30	−33	.87		8.7
Swift Current, Saskatchewan	2,392												
Medicine Hat, Alberta	2,365	27.47	30.09	+.02	5.5	.0	15.5	−4.6	41	−26	1.14	−5.7	11.4
Calgary, Alberta	3,540												
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450												
Battleford, Saskatchewan	1,592												
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262												
Victoria, British Columbia	230												
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20												
Prince Rupert, British Columbia	170												
Hamilton, Bermuda	151												
LATE REPORTS FOR DECEMBER 1935													
Cape Race, Newfoundland	99				33.3		37.7	28.9	46	12	4.33		3.4
Minnedosa, Manitoba	1,690	28.21	30.14	+0.12	7.3	+1.6	16.6	−2.0	33	−28	.38	−0.24	3.8
Le Pas, Manitoba	860				3.2		11.6	−5.1	30	−30	.27		2.7
Qu'Appelle, Saskatchewan	2,115												
Moose Jaw, Saskatchewan	1,759				15.4		25.3	5.5	42	−18	.68		4.2
Swift Current, Saskatchewan	2,392	27.42	30.05	+.06	21.0	+5.0	29.5	12.5	42	−17	.52	−.26	4.7
Calgary, Alberta	3,540	26.28	30.09	+.15	25.7	+7.5	36.1	15.3	48	−8	.44	−.15	4.4
Kamloops, British Columbia	1,262	28.76	30.09	+.15	33.7	+4.8	37.2	30.2	48	23	.47	−.31	4.5
Prince Rupert, British Columbia	170				40.6		45.8	35.5	56	27	13.24		T

TABLE 3.—*Severe local storms, January 1936*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Sandy Hook, N. J.	2					Sleet	Travel dangerous; several automobile accidents due to skidding; some pedestrians injured by falling on icy pavements.
New York State	2					do	Icy roads over most of the State; all traffic delayed.
Harrisburg, Pa.	2					Glaze	Streets, fences, trees, and wires coated with ¼ inch of ice; many persons slipped and fell with more or less serious injuries.
Kenosha, near, Wis.	11-12			4		Gale	Storm started about 5 p. m., of the 11th; 4 men in fishing boat, unable to reach shore because of ice floes, perished; Coast Guards unable to effect rescue.
North Head, Wash.	12			34		Wind	Freighter *Iowa* went aground and all aboard lost.
Vancouver, Wash.	12					do	Damage to orchards, shrubs, and power lines.
Boulder, Colo.	12-13				$770	Wind	Property damaged.
Pueblo, Colo.	15	11 a. m.-4 p. m.				Gale and dust	Wind of 45 miles an hour; homes and business houses filled with thick film of powdery dust; visibility reduced to ¾ mile; traffic impeded; some damage to trees, foliage, sheds, and roofs; amount not estimated.
Keokuk, Iowa	17					Glaze	Streets very slippery.
Iowa	17-18					Blizzard	Amount of snow varied from 3 inches in the north to 20 inches in the south; highway traffic paralyzed; railroad schedules disrupted and many cancellations occurred; State Highway Commission battled day and night at hopeless task of keeping the primary roads open; all country roads definitely blocked.
Milwaukee, Wis.	17-18					Snow	14.4 inches of snow fell in 24 hours; 16-foot drifts reported in some places, while other spots were practically bare.
Fort Payne, Ala.	18	A. m.		4		Tornado	Cloudburst followed tornado making travel to the scene difficult; dozen or more persons injured, 3 seriously; several homes and a garage wrecked; others damaged.
Chipley, Fla.	18	7 p. m.	100	7	25,000	do	25 persons injured; property loss between $10,000 and $40,000; no crop loss; livestock and chickens killed; trees uprooted.
Edison, Ga., vicinity of	18	11:30 p. m.		7	10,000	do	Negro woman and baby picked up from a mattress and carried into a swamp were found uninjured the following day; water tank carried nearly a quarter of a mile; in Atlanta a house was partly demolished; destructive winds reported from Athens, Augusta, Elberton, Jackson, Lorane, and Millen.
Hartford, Conn.	18-19					Snow and sleet	14.6 inches of snow and sleet recorded during the 2 storms of the 18th and 19th; all highways kept open and traffic moving; no serious accidents reported.
Tennessee, entire State	18-19					Snow	Snow measurement of 5 inches from Williamson and Dickson Counties northward to the Kentucky line; 7 inches in Davidson County.
Dallas, Tex.	18-20					Snow and ice	Snowfall 1.7 inches on the 18th, with some melting immediately after falling and freezing during the day and night; streets and highways slippery; many persons injured; some loss to crops.
Clermont, Fla.	19	9:15 a. m.	167	0	18,500	Tornado	Property damage $3,500; loss to crops, mostly citrus, $15,000; path 5 miles long.
Trenton, N. J.	19					Sleet	3.8 inches of sleet, the heaviest since February 1920, interrupted traffic.
Charlotte, N. C.	19	9:43 a. m.				Severe line squall	Maximum velocity of 46 miles per hour; considerable minor damage reported.
Wilmington, N. C.	19	A. m.				Gale	Some property damage.
Greensboro, N. C.	19				2,000	Wind	Property damaged.
New York State, except southeastern portion.	19			9		Blizzard	Great delay in automobile, bus, and train service; many motorists stalled on highways.
Scranton, Pa.	19					Heavy snow and wind.	Heaviest snowfall ever recorded by the Weather Bureau in Scranton in any one storm, 20 inches; main highways almost impassable; secondary roads blocked; bus and train schedules interrupted.
Block Island, R. I.	19				1,400	Sleet and glaze	Damage to wires, poles, and roofing.
South Carolina, northern and central portions.	19	A. m.			200,000	Wind	Extensive property damage; trees uprooted; fences, poles, and wires blown down.
Harrisburg, Pa.	19-20					Heavy snow and wind.	Traffic tied up by 14 inches of drifting snow; many schools closed for day or two; several days before conditions approached normal due to high winds on the 20th.
Marquette, Mich.	22	A. m.				Wind and snow	Snow blown in such quantities that visibility was zero at times; schools dismissed at noon; almost no movement of wheeled traffic of any sort; very high seas dashed over breakwater; fishermen, alarmed by the rapidly falling pressure, made port before noon.
Minnesota, entire State	22					Wind	High winds with unusually low temperatures, assumed blizzard proportions, seriously delaying traffic over the entire State; several fatalities resulted from the storm.
Pittsburgh, Pa.	22					Wind and snow	Roads out of the city impassable because of snow drifts; many motorists stranded along highways.
Northern New York	23-23			15		Blizzard	4 inches of dry snow fell; severe winds caused drifting; traffic handicapped; many stalled automobiles, trucks, and busses had to be abandoned. Buffalo airport cut off about 36 hours because of drifts; storm conditions severe throughout northern New York; numerous highways almost impassable for from 12 to 36 hours; visibility extremely poor; 15 deaths attributed to the storm.
Dayton, Ohio	22-23					do	This storm the worst of the winter; several injuries and deaths attributed to the cold; numerous interruptions to car and bus service due to frozen air brakes and snapped trolleys; automobiles rendered unserviceable; schools closed.
Cleveland, Ohio	22-23					Snow and wind	Many roads blocked by drifts; busses stalled and abandoned; hundreds of persons marooned; much damage because of severe cold; hundreds of automobiles disabled; wires snapped; many persons had hands and feet frozen; few deaths from exposure.
Evansville, Ind.	22-31					Snow and ice	The cold wave caused ice to form with lowering temperature; all traffic dangerous; 4 pedestrians had broken bones because of falls on the 22d; numerous motor accidents occurred; damage estimated to be in the thousands.
Chattanooga, Tenn.	23-24	10:02 a. m. of 23-6 a. m. of 24.				Snow	6 inches of snow, the heaviest in the past 7 years, covered the ground; traffic delayed; 16 persons treated for injuries from falling.
Georgia	29-30					do	One of the most notable snowstorms ever known in Georgia; 4 inches covered the ground as far south as Newnan, Griffin, Greensboro, Monticello, and Washington; in Atlanta, the snowfall was 8 inches, the largest amount ever measured in a single storm.
Wilmington, N. C.	29-30	11:15 p. m. of 29-2:15 p. m. of 30.				do	Snowfall of 6.5 inches, heaviest fall since December 1915; transportation on city streets and highways considerably impeded for several days.
Dallas, Tex.	29-31					Rain, sleet, and snow.	Rain, sleet, and snow on the afternoon of the 29th; many accidents due to slippery streets and highways.

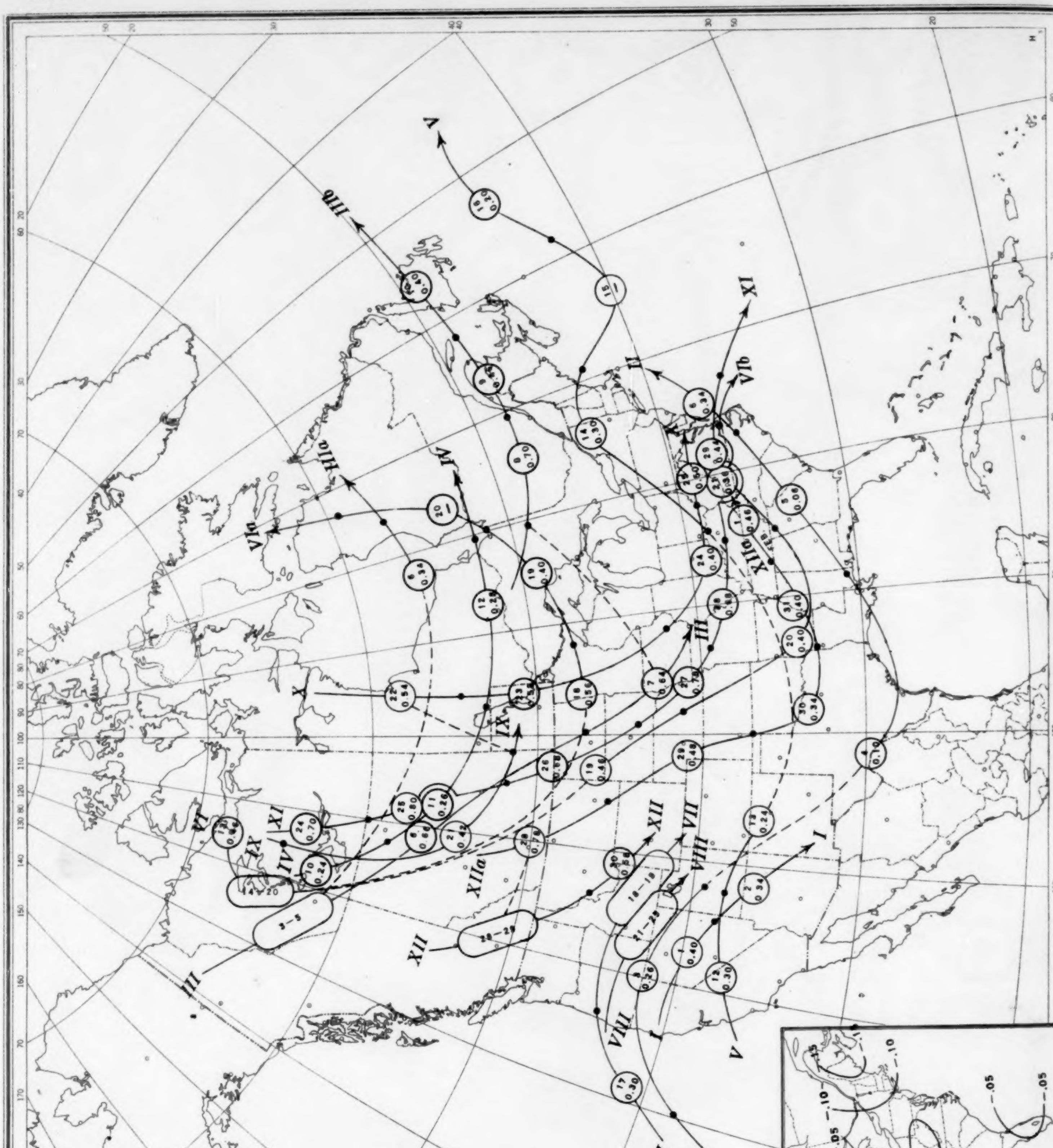
U. S. GOVERNMENT PRINTING OFFICE: 1936

Chart I. Departure (°F.) of the Mean Temperature from the Normal, January 1936

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency

Chart II. Tracks of Centers of Anticyclones, January 1936. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. P. Day)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

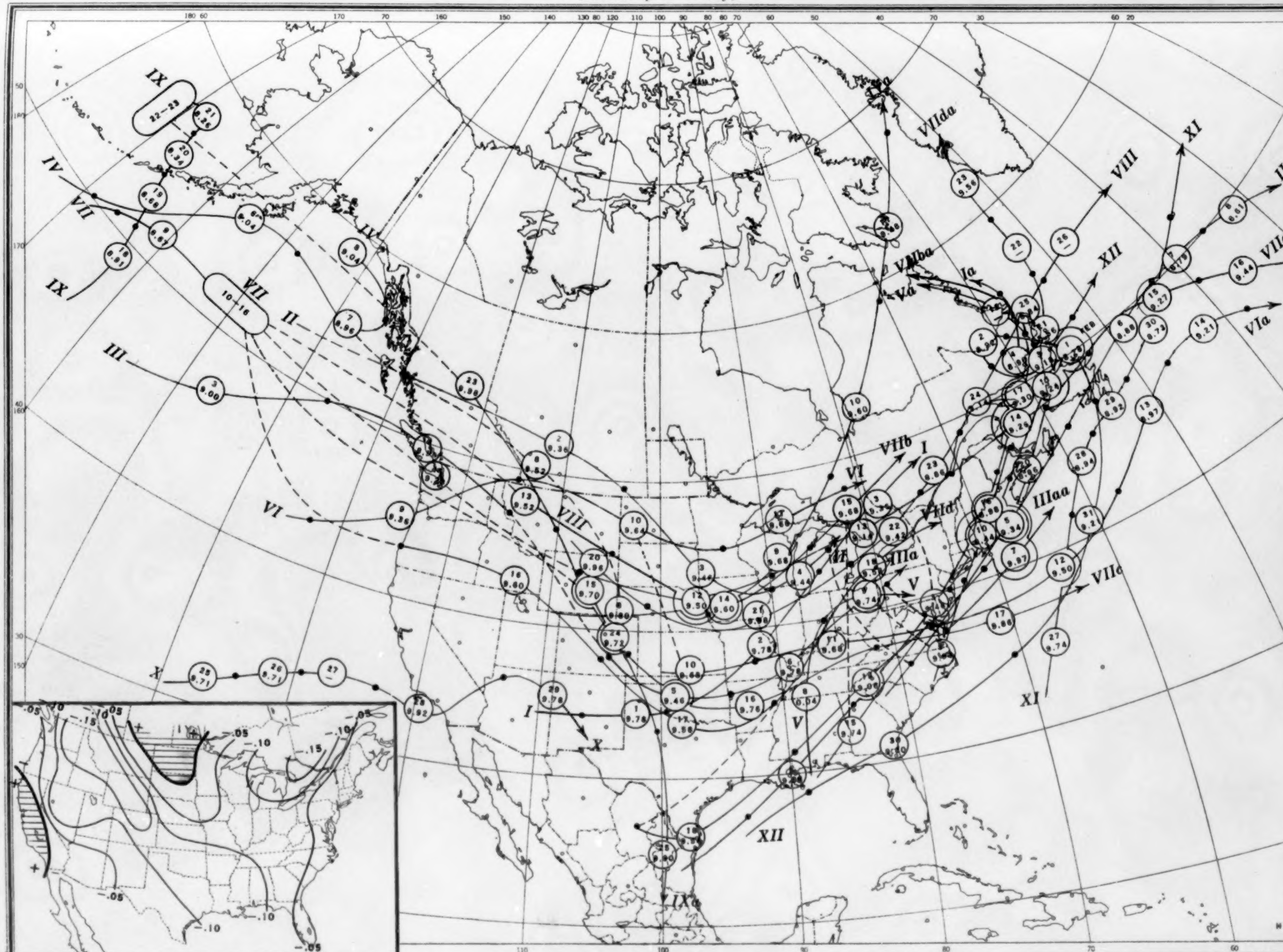
Chart III. Tracks of Centers of Cyclones, January 1936. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, January 1936. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, January 1936

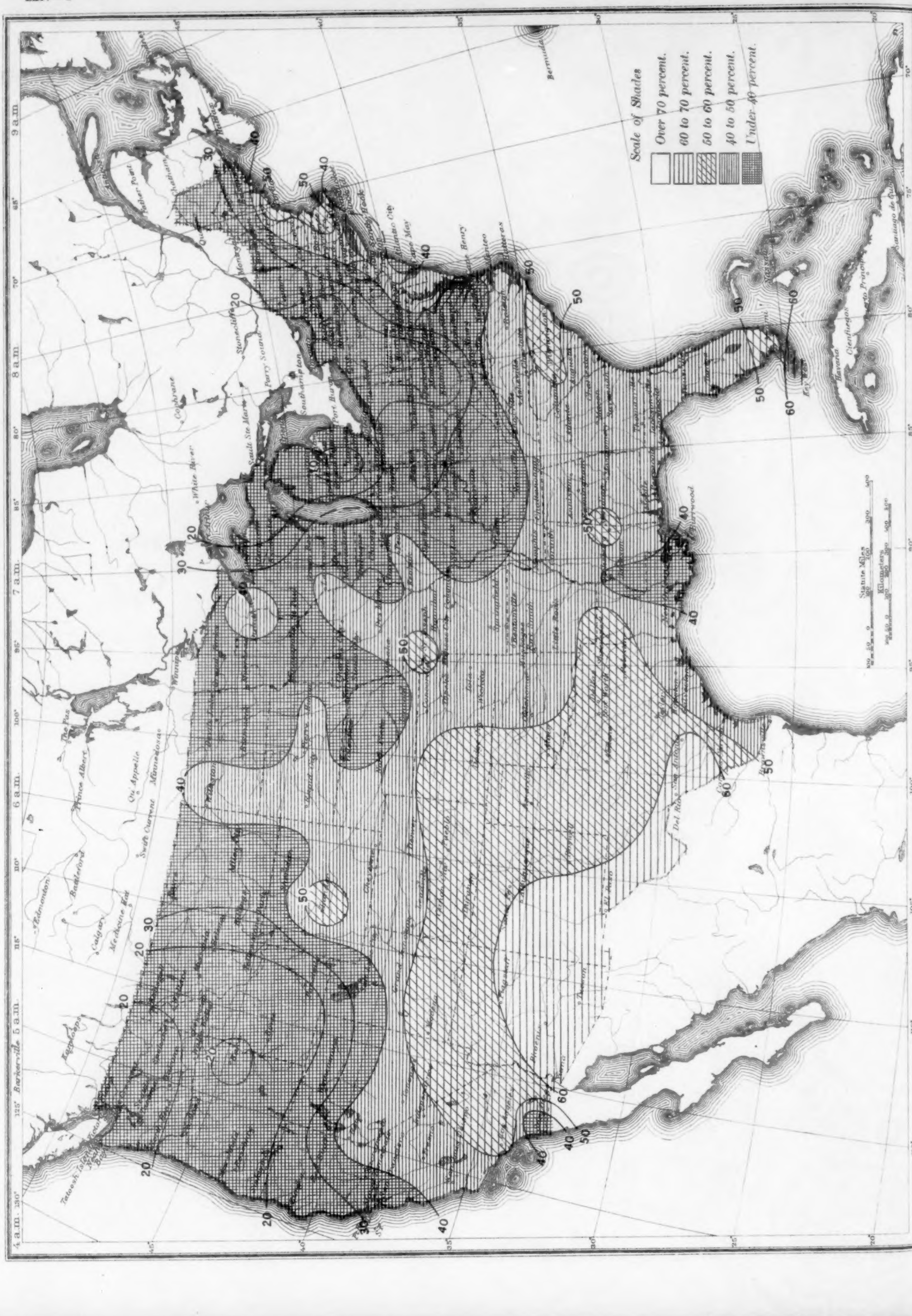


Chart V. Total Precipitation, Inches, January 1936. (Inset) Departure of Precipitation from Normal

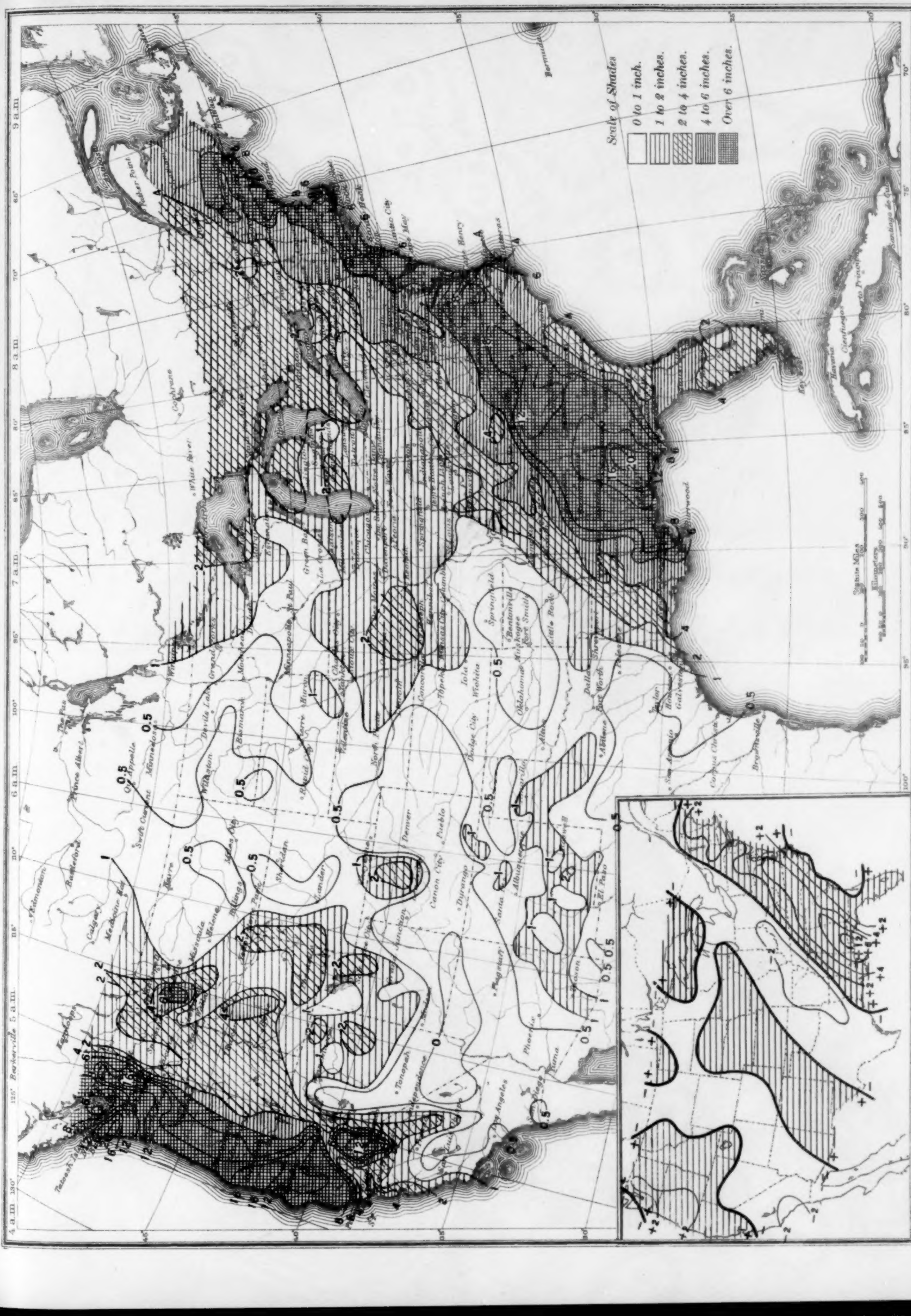


Chart V. Total Precipitation, Inches, January 1936. (Inset) Departure of Precipitation from Normal

Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, January 1936

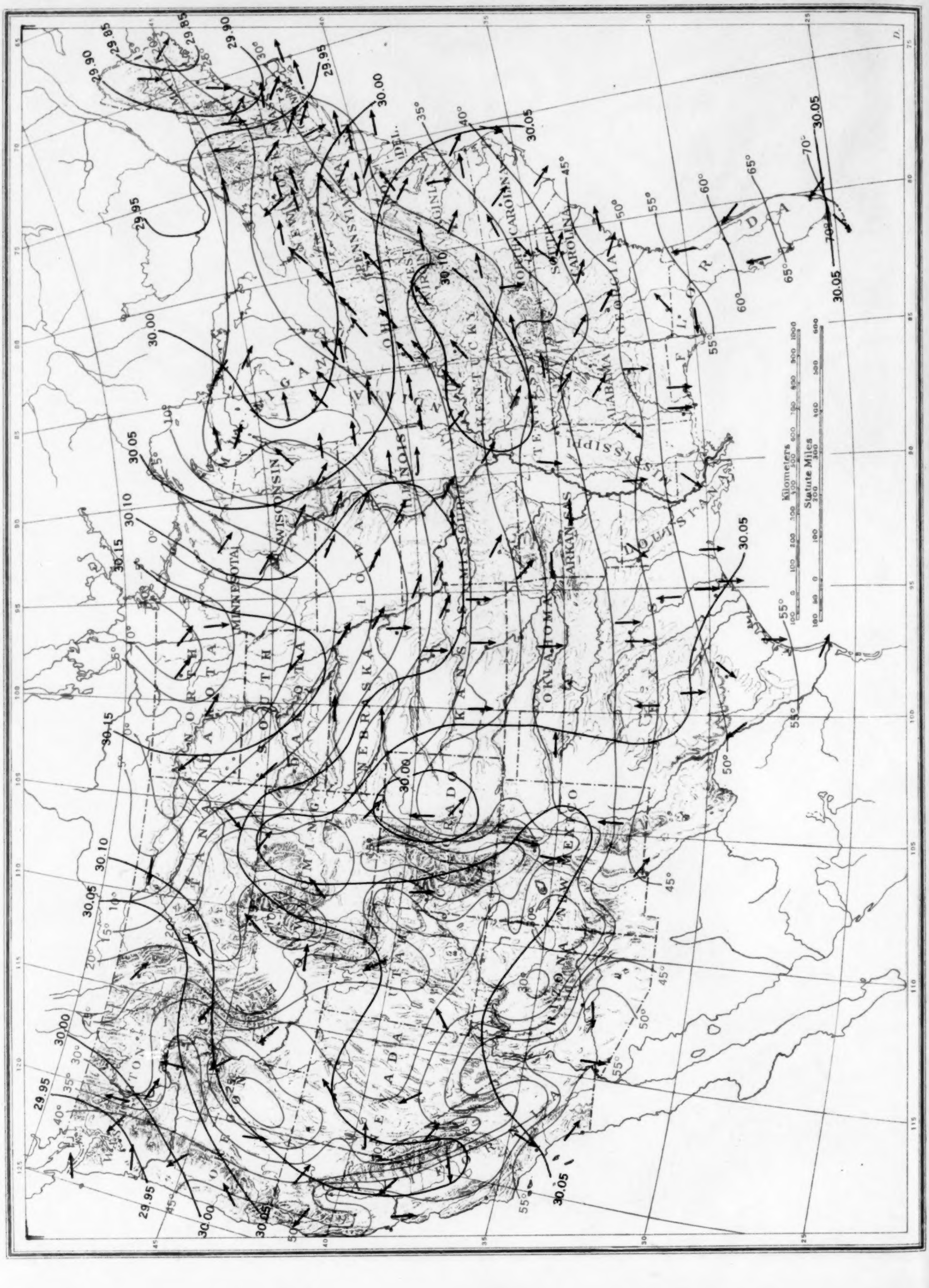


Chart VII. Wind Roses for Selected Stations, January 1936
(Plotted by W. W. Reed)

Chart VIII. Total Snowfall, Inches, January 1936. (Inset) Depth of Snow on Ground at 8 p. m., Monday, February 3, 1936

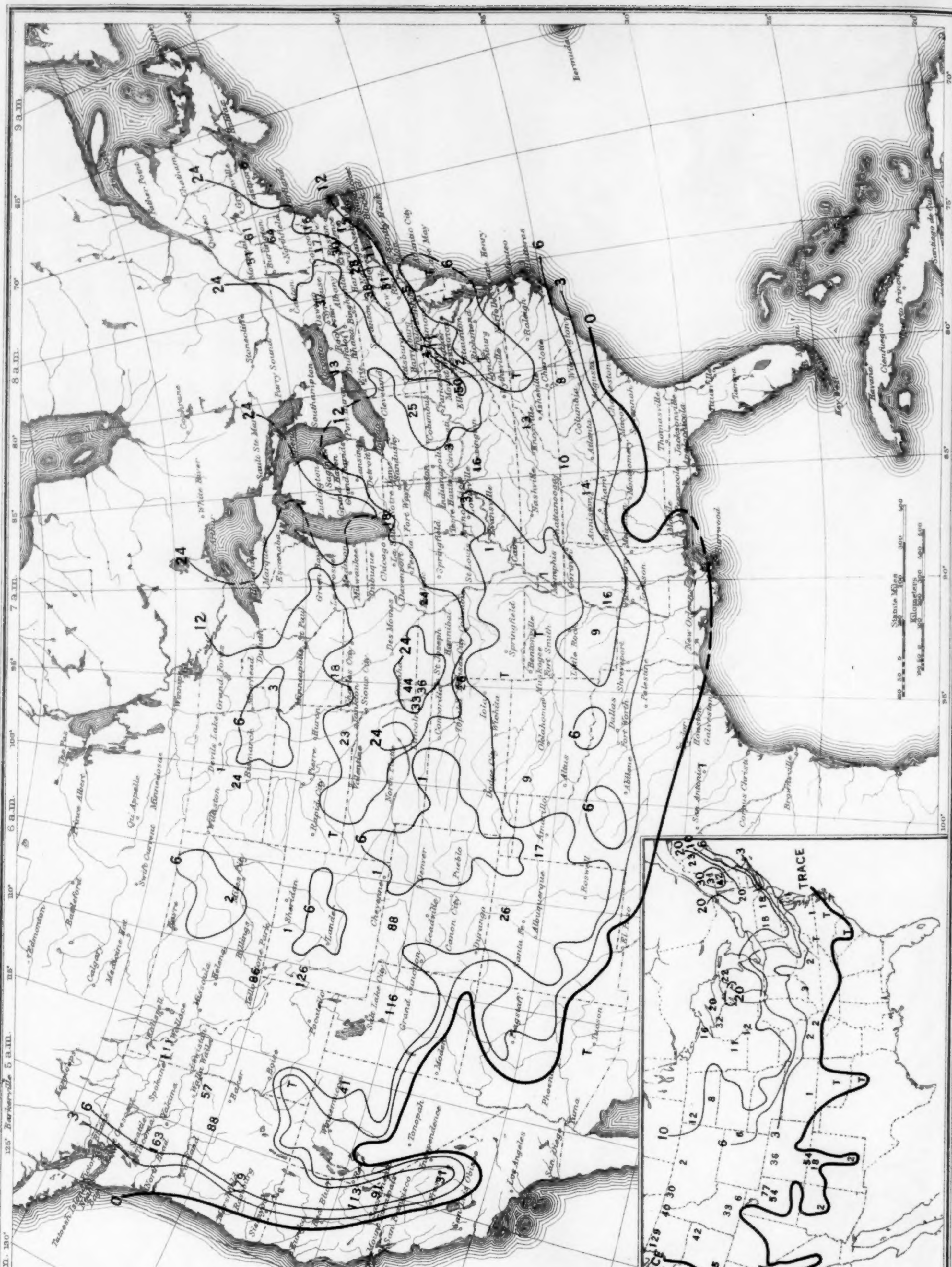


Chart IX. Weather Map of North Atlantic Ocean, January 6, 1936

Chart IX. Weather Map of North Atlantic Ocean, January 6, 1936
(Plotted from the Weather Bureau Northern Hemisphere Chart)

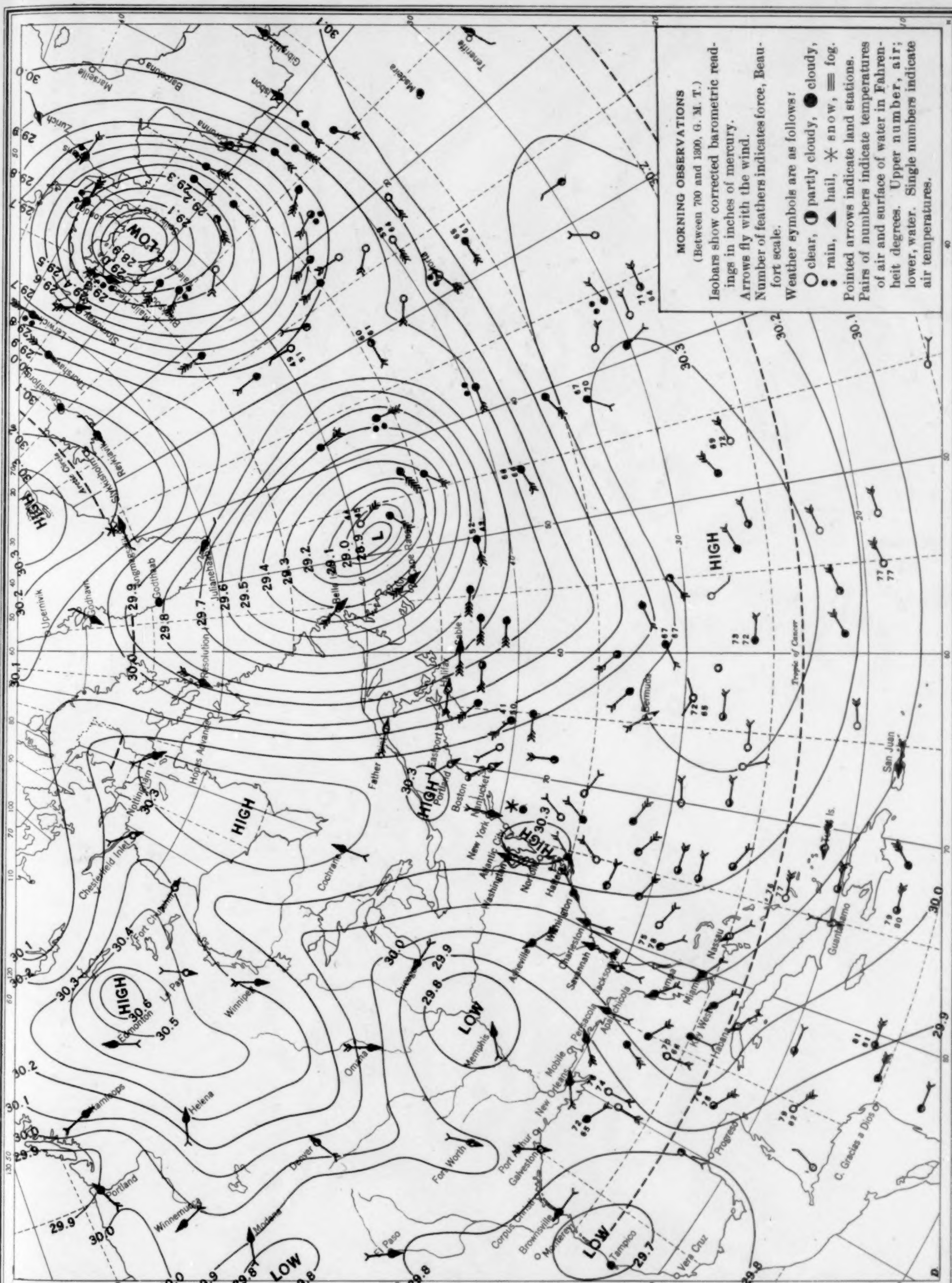


Chart X. Weather Map of North Atlantic Ocean, January 16, 1936
(Plotted from the Weather Bureau Northern Hemisphere Chart)